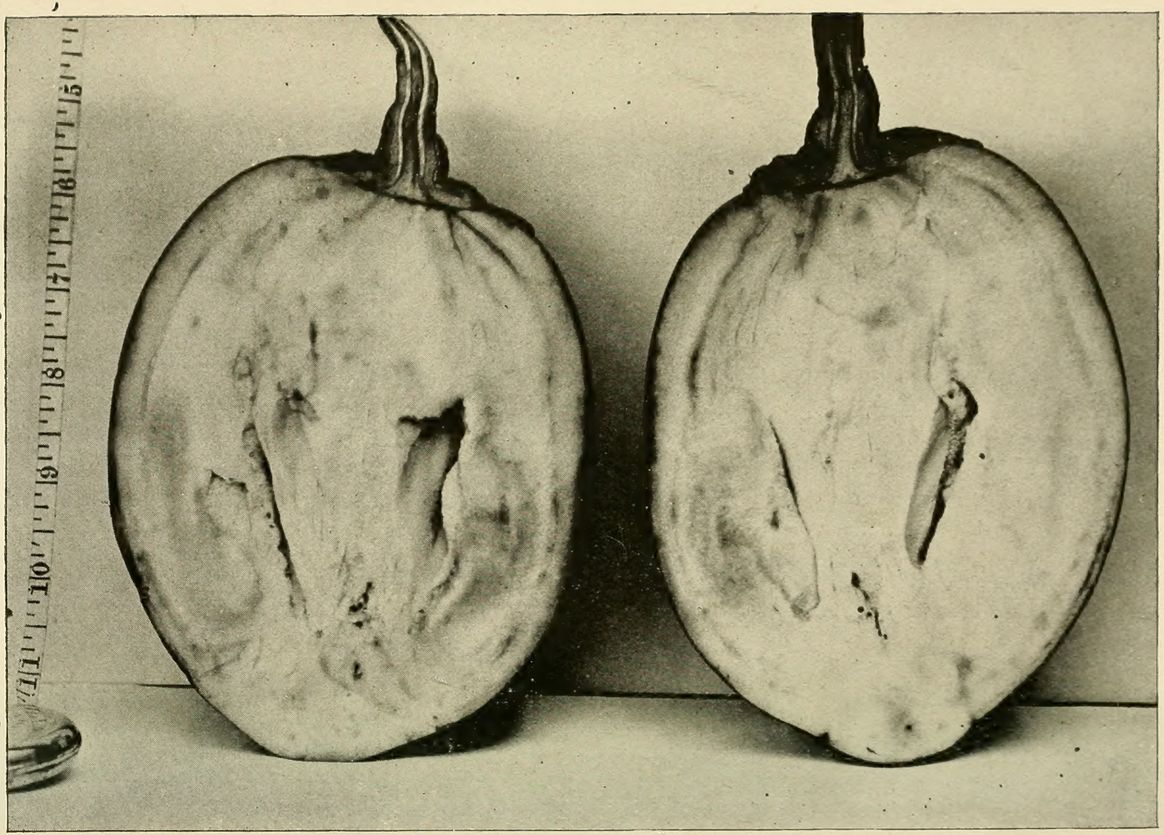


SEEDLESS EGG FRUIT. See Page 46.

ANNUAL REPORT

OF THE

MAINE STATE COLLEGE

AGRICULTURAL EXPERIMENT STATION

ORONO, MAINE.

1892.

BANGOR:
CHAS. H. GLASS & CO., PRINTERS,
1893.

MAINE STATE COLLEGE,

AGRICULTURAL EXPERIMENT STATION.

STATION COUNCIL.

B. F. BRIGGS, ESQ., Auburn,	Committee of Trustees.
RUTILLUS ALDEN, ESQ., Winthrop,	
ARTHUR L. MOORE, ESQ., Waterville,	

ADVISORY MEMBERS.

B. W. MCKEEN, ESQ., Fryeburg, *State Board of Agriculture.*

D. H. KNOWLTON, ESQ., *State Pomological Society.*

PROF. I. O. WINSLOW, St. Albans, *Maine State Grange.*

MEMBERS FROM STATION STAFF.

M. C. FERNALD, PH. D., ... President College,

PRESIDENT.

W. H. JORDAN, M. S., ... Director Station,

SECRETARY.

WALTER BALENTINE, M. S. . . . . Professor of Agriculture.

F. L. HARVEY, Ph. D., ... Professor of Natural History.

F. L. RUSSELL, V. S., ... Veterinarian to Station.

W. M. MUNSON, B. S., ... Professor of Horticulture.

STATION OFFICERS.

W. H. JORDAN, M. S.	Director.
M. C. FERNALD, PH. D.,	Meteorologist.
WALTER BALENTINE, M. S.,	Experimental Agriculture.
F. L. HARVEY, PH. D.,	Botanist and Entomologist.
J. M. BARTLETT, M. S.,	Chemist.
L. H. MERRILL, B. S.,	Chemist.
F. L. RUSSELL, V. S.,	Veterinarian.
W. M. MUNSON, B. S.,	Horticulturist.
F. P. BRIGGS, B. S.	Assistant in Botany and Entomology.
H. P. GOULD,	Assistant in Horticulture.
A. M. SHAW,	Foreman on Farm.
MRS. J. HAMLIN WAITT,	Stenographer and Clerk.

TREASURER'S REPORT.

THE MAINE AGRICULTURAL EXPERIMENT STATION.

In account with

THE UNITED STATES APPROPPIATION.

RECEIPTS.

From the Treasury of the United States as per appropiation for the year ending June 30, 1892		$15,000 00

EXPENDITURES.

Chemical Laboratory	$ 434 54	
General Expense	297 77	
Field and Feeding	790 34	
Horticultural Department	793 34	
Head House	468 93	
Library	62 97	
Printing	1,667 35	
Stationery and Postage	108 00	
Travelling Expenses	147 00	
Trustee Expenses	50 40	
Construction and Repairs	277 19	
Botany and Entomology	33 50	
Fertilizer Inspection	209 16	
Meteorology	20 50	
Veterinary Science	28 46	
Fuel Account	294 45	
Salaries	9,316 10	
		$15,000 00

I hereby certify that the above is a correct statement of the amount expended by the Maine Experiment Station for the year ending June 30, 1892.

GEO. H. HAMLIN,
Treasurer of Trustees, Maine State College of Agriculture and the Mechanic Arts.

I hereby certify that I have examined the accounts of the Maine Experiment Station for the fiscal year ending June 30, 1892: that I have found the above to be a correct statement of expenditures both as to amount and classification, for all of which proper vouchers are on file.

HENRY LORD,
Audtior of the Trustees, Maine State College of Agriculture and the Mechanic Arts.

I hereby certify that the above are the signatures of the Treasurer and Auditor of the Trustees of the Maine State College of Agriculture and the Mechanic Arts.

W. H. JORDAN,
Director of Station.

DIRECTOR'S REPORT.

M. C. Fernald, Ph. D., President Maine State College:

SIR:—The work of the Maine Experiment Station for the year 1892, a report concerning which I have the honor to submit herewith, has been conducted along the lines previously established. It has included the following: 1st, inspection of fertilizers; 2d, analyses of cattle foods, including certain patent foods which are offered for sale at greatly advanced prices. An attempt has been made to demonstrate to the farmer the very poor economy of purchasing the latter. 3d, investigations concerning the secondary effects of pollination. In presenting these results, Prof. Munson has taken the occasion to collect in the form of a monograph all the avilable information which has been published on the subject. 4th, experimental work on varieties and methods of treatment of certain garden vegetables, including cabbages, tomatoes and egg plants. 5th, contents, cultivation and care of small and large fruits which are being tested. 6th, spraying experiments, specially with reference to the apple scab and codling moth. 7th, the identification and description to inquirers of such injurious plants and insects as are sent to the Station. 8th, investigations in plant nutrition bearing upon the economical use of crude fertilizing materials. 9th, digestion experiments. 10th, feeding experiments with swine and milch cows.

PUBLICATIONS OF THE STATION.

The publications of the Station by means of which the results of the above experiments and investigations are set forth have consisted of a report issued in five parts. In this report have been included everything excepting the digestion and feeding experiments. These have so far been in the immediate charge of the Director of the Station, but owing to increased duties in connection with the World's Fair, he has not been able either to undertake the past season as extensive experiments or to report them as promptly as otherwise would have been the case. Only a limited edition of Part 2, of the report (Secondary Effects of Pollination) was issued as it was sent out only to newspapers, experiment stations and experiment station workers. The reason

for this was that the publication was of a strictly scientific nature and while presenting the results which it is hoped will lead to practical conclusions eventually, its contents were of such a nature as to be of little general interest. Besides the five parts of the station report, there was also issued a bulletin on the Babcock Milk Test and six newspaper bulletins, the latter being designed as a concise and simple statement of the outcome of certain practical experiments.

Station Exhibit at the Columbian Exposition.

At a meeting of the association of colleges and experiment stations held at Champaign, Ill., in November, 1890, it was voted that the experiment stations unite with the United States Department of Agriculture in making a co-operative exhibit at the Columbian Exposition. A committee of five was appointed to act in conjunction with the Central Office of Experiment Stations in forming and executing plans for this exhibit. It was decided that instead of inviting each experiment station to make an individual exhibit, thus causing very much of repetition, it would be better to co-ordinate the total exhibit into sections, each section to represent a particular subject. I was invited to take immediate charge of the section devoted to Animal Nutrition and after consultation with yourself agreed to do so. It was evident from the first that because of the nature of this subject, the exhibit could not consist so much of objects of special interest as of a graphic display of results. For instance, it was very evident that the main factor of the exhibit must be a display of the relation of food and growth under varying conditions, and if such a display were to mean anything as an expression of the work of American experiment stations, it must be based upon their experimental data. This necessitated the review of all the station literature bearing upon experiments in animal nutrition. All the experiment stations that had conducted feeding experiments were invited to assist in this work, and some of them very kindly furnished the data of their own feeding experiments so arranged and digested as to be immediately useful in obtaining certain necessary general averages. The required data from swine feeding experiments were very kindly furnished by the Office of Experiment Stations from manuscript prepared by Dr. Armsby, of State College, Pa.

In order to obtain the necessary figures pertaining to milk production and the growth of bovines and sheep, there were used the

results of one hundred and twelve feeding experiments made by American stations. As before stated, many of these results were put into the desired form by the stations making the experiments, but considerably more than half of them were worked up in this office from the original data. Moreover, a large part of the exhibit itself has been prepared here. All of this required my personal attention. I make the above statements as an explanation why that line of experimental work in which I am immediately interested has been to some extent neglected.

Inspection of Fertilizers.

As in previous years, the time of the station force has in part been devoted to the inspection of fertilizers. There is a fair prospect that this will not again be done at the expense of the funds supplied by the United States Government. It now appears probable that the Legislature soon to meet will be asked to enact a law which will provide for the expense of this inspection either by direct appropriation from the State, or by requiring a license fee from fertilizer manufacturers doing business in the State. The movement in this direction has the approval of members of the Board of Agriculture and of others who understand the exegencies of the case.

Work in Plant Nutrition.

Through you I desire to urge upon the attention of the Board of Trustees a proposed enlargement of our work in plant nutrition. Since the establishment of the Experiment Station under the provisions of the Hatch Act, the experiments and investigations in plant feeding have been under the immediate charge of Prof. Balentine. He has attempted to reach beneficial results through field experiments on the College Farm, through experiments conducted by farmers in different parts of the State, and through more or less experimentation in pots with a view to a more exact work than can be done in the field.

It is very evident and has been for some time that not only are the errors of field experimentation very large, but that the usefulness of this method of work is limited to the testing of theories as to the correct methods of maintaining fertility. An exact study of the fact and principles of plant nutrition must be accomplished by some other method. It is a noticable fact that American Experiment Stations are giving comparatively little

attention to this subject, at least in the way of rigid scientific investigation, and an inviting and important field of work seems to be open. The nutrition of animals has received a much larger amount of attention.

Experiments now under way in the forcing house give promise of a far greater degree of success than has been possible under previously existing conditions and Prof. Balentine is desirous that there shall be erected a new forcing house which shall be entirely utilized, for a time at least, by experiments of this kind. This idea has my most hearty endorsement and through you I wish to urge upon the trustees the importance of developing this line of investigation. The present forcing house is entirely inadequate to accommodate any additional experiments. As this new forcing house would stand in a prominent place, it should be somewhat more ornamental than the one already built, and not less than $1,500 should be available for its construction.

Acknowledgements.

The Experiment Station is under obligation to the following parties for gifts of various kinds:

Donations 1892.

O. M. Lord, Minnesota City, Minn., apple cions.

J. S. Harris, La Crescent, Minn., apple cions.

C. G. Patten, Charles City, Iowa, apple cions.

Jewel Nursery Co., Lake City, Minn., 6 Thompson Seedling Apple Trees; 6 Windom Dewbery; 6 North Star Currants.

Ellwanger & Barry, Rochester, N. Y., specimen fruits of autumn pears.

Field Force Pump Co., Lockport, N. Y., 1 Little Gem spraying pump.

The following newspapers and other publications are kindly donated to the Station by the publishers during 1892:

Farmers' Home, Dayton, Ohio.

Holstein Friesian Register, Boston, Mass.

Farm and Home, Springfield, Ill.

Jersey Bulletin, Indianapolis, Ind.

Monthly Bulletin, Philadelphia, Pa.

Farmers' Advocate, London, Ont.

Maine Farmer, Augusta, Me.

Southern Cultivator, Atlanta, Ga.

American Dairyman, New York, N. Y.
The Pharmaceutical Era, Detroit, Mich.
The Sun, Baltimore, Md.
Massachusetts Ploughman, Boston, Mass.
Practical Farmer, Philadelphia, Pa.
New England Farmer, Boston, Mass.
Louisana Planter, New Orleans, La.
Mirror and Farmer, Manchester, N. H.
Texas Farmer, Dallas, Texas.
Hoard's Dairyman, Ft. Atkinson, Wis.
Iowa Farmer and Breeder, Cedar Rapids, Iowa.
Detroit Free Press, Detroit, Mich.
Orange County Farmer, Port Jervis, N. Y.
Farm Journal, Philadelphia, Pa.
Delaware Farm and Home, Wilmington, Del.
The Western Rural, Chicago, Ill.
American Cultivator, Boston, Mass.
Farmers' Review, Chicago, Ill.
The Rural Canadian, Toronto, Ont.
Vick's Magazine, Rochester, N. Y.
The Farm and Dairy, Ames, Iowa.
The Clover Leaf, So. Bend, Ind.
New York World. (weekly)
The Grange Visitor, Lansing, Mich.
The Industrial American, Lexington, Ky.
The American Grange Bulletin and Scientific Farmer, Cincinnati, Ohio.
Agricultural Epitomist, Indianapolis, Ind.
The Prairie Farmer, Chicago, Ill.

W. H. JORDAN,
Director.

MAINE STATE COLLEGE,
ORONO, ME., Dec. 31, 1892.

TABLE OF CONTENTS.

PART I.

PART II.

PART III.

PART IV.

BULLETIN NO. 4, Second Series.

(AT END OF VOLUME.)

ILLUSTRATIONS.

INDEX.

INSPECTION OF FERTILIZERS.

The inspection of fertilizers by the Maine Experiment Station for the year 1892 has required the analysis of seventy-four brands of mixed fertilizers involving the selection of one hundred and ninety samples. In order to secure these samples, it has been necessary to send an agent into nearly every section of the State. Samples were taken in forty one cities and townships, often at several points in the same township. An effort is made to begin this work in March, but it is usually found that new goods have been shipped to but few places so that a successful canvass of the State can not be carried on until April, therefore the completion of the sampling and analytical work can not be reached until late in June. It will be noticed that three samples of each brand have not been secured in all cases.

In general this has been owing to the following causes: Selling of the fertilizer at but very few points, and finding only the goods held over from last year's sales in the hands of nearly all the agents visited.

Selection of Samples.

Samples for 1892 were selected by Mr. S. H. T. Hayes, an agent of the Station, acting under its instructions. The samples were drawn from three or four packages, mostly one hundred pound bags, so that in all cases where three samples were taken the analysis represents from nine to twelve packages of the goods. In some cases as many as five samples were taken.

The drawing of the samples is accomplished by means of a sampling tube which can be made to reach every portion of the package, and as several drafts are made from each package, it is readily seen that the method of taking samples is a very thorough one, and there is no good reason for supposing that the contents of the glass jar that is forwarded to the Station do not fairly represent the goods sampled. In every instance a sample exactly similar in composition to the one taken to the station is left in the hands of the agent selling the goods, thus giving the manufacturers an opportunity, by procuring an analysis of this sample, to check the analytical work of the Station.

The Trade Values of Fertilizers for 1890.

The trade values given below which are used by this Station are those "agreed upon by the experiment stations of Massachusetts, New Jersey, Rhode Island and Connecticut for use in their respective states during 1892. The valuations obtained by use of the following figures will be found to agree fairly with the *average retail price* at the large markets of standard raw materials such as:"

Sulphate of Ammonia,	Azotin,
Nitrate of Soda,	Ammonite,
Dried Blood,	Dry Ground Fish,
Muriate of Potash,	Bone or Tankage,
Sulphate of Potash,	Ground So. Carolina Rock,
Plain Superphosphates.	

	Cts. per lb.
Nitrogen in ammonia salts	17½
nitrates	15
Organic nitrogen in dry and fine ground fish, meat and blood	16
in cotton seed meal and castor pomace	15
in fine bone and tankage	15
in fine medium bone and tankage	12
in medium bone and tankage	9½
in coarser bone and tankage	7½
in hair, horn shavings and coarse fish scrap	7
Phosphoric acid, soluble in water	7½
" in ammonium citrate	7
in dry ground fish, fine bone and tankage	7
in fine-medium bone and tankage	5½
in medium bone and tankage	4½
in coarser bone and tankage	3
Potash as high-grade Sulphate and in forms free from Muriate or Chlorides	5½
as muriate	4½

"These trade values are the average prices at which in the six months preceding March the respective ingredients could be bought at retail for cash in our large markets, Boston, New York and Philadelphia, in the raw materials which are the regular source of supply. They also correspond to the average wholesale prices for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations."

The sale of "standard raw materials" in Maine is too small to allow an estimation of values upon the basis of local market prices, so the figures as agreed upon in other New England States, where the subject is very ably and thoroughly studied, are taken for use by this Station.

The Valuation of Superphosphates and Mixed Goods.

These trade values are applied to the valuation of Superphosphates and all mixed goods, as follows:

It is assumed that the organic nitrogen of these goodhass for its source such materials as dried blood, ground fish, or nitrogenous substances of equally good quality, unless a special examination of some particular brand shows that inferior material like

leather has been used. Organic nitrogen in mixed goods is therefore valued at sixteen cents per pound. As nitrogen in nitrates is rated for 1892 at only a cent less per pound than organic nitrogen, and as with but few exceptions the nitrates are present in very small quantities, no difference has been made in computing the "estimated value" between organic and nitric nitrogen, but both have been valued at sixteen cents. The small increase in the "estimated value" thus caused, while slightly favorable to certain manufacturers, can certainly do the consumer no serious harm. The nitrogen present in ammonia salts is reckoned at seventeen and one-half cents.

The insoluble phosphoric acid of mixed fertilizers is reckoned at two cents per pound, coming as it does largely from mineral phosphates, and in any case being much the least valuable portion of the original material.

The potash is valued at the price of that ingredient in the muriate, unless the chlorine present in the fertilizer is not sufficient to combine with it, in which case the excess of potash is reckoned at the price of the sulphate.

The valuation of a fertilizer is obtained by multiplying the percentages of the several ingredients by twenty (which gives the pounds per ton), and these products by the prices per pound, and the sum of the several final products is the market value of the fertilizing ingredients in one ton. For instance the "station valuation" of fertilizer No. 855 was obtained as follows:

2.65% Nitrogen,	53. lbs. per ton	@ 16 cts.	—$8.48.
6.26% Soluble Phos. Acid,	125.2 " " "	@ 7½ "	— 9.39.
3.80% Rev. " "	76. " " "	@ 7 "	— 5.32.
1.22% Insol. " "	24.4 " " "	@ 2 "	— .49.
1.77% Potash,	35.4 " " "	@ 4½ "	— 1.59.
		Valuation,	$25.27

Change in Method.

In past years separate analyses have been made of the samples representing the same fertilizer. At present equal quantities of all the samples are mixed, and an analysis of this mixture is assumed to give the same result as would be reached by averaging the analyses of the several samples, a method which is undoubtedly correct.

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
997	Alkaline Bone	E. Frank Coe, New York, N. Y.,	W. P. Bessey, Freedom	
855	Americus Amm. Bone Superphosphate	Williams & Clark Fert. Co., New York, N. Y.,	S. D. Edwards, Oxford	$36.00
868			Carleton Bros., Portland	32.00
963			L. A. Knowlton, Belfast	35.00
869	Americus Corn Phosphate	Williams & Clark Fert. Co., New York, N. Y.,	Carleton Bros., Portland	32.00
959			E. B. Gardiner, Bucksport.	
974			L. A. Knowlton, Belfast	36.00
957	Amm. Bone Super. (Standard Grade)	E. Frank Coe, New York, N. Y.,	Morrison & Joy, Ellsworth	36.00
981			A. A. Howes, Unity	
986			S. L. Small, Dexter	32.00
859	Bay State Fertilizer for Seeding Down	Clark's Cove Fert. Co., New Bedford, Mass.,	A. A. Mitchell, Portland	
971			L. A. Knowlton, Belfast	27.00
1017			J. L. Bridgham, No. Auburn	
990	B. D. Sea Fowl Guano	Bradley Fertilizer Co., Boston, Mass.,	L. F. Ireland, Corinna	31.00
1029			Willis Cobb, Winthrop	
1035			Steward Bros., Skowhegan.	30.00
853	Bowker's Amm. Bone Fertilizer	Bowker Fertilizer Co., Boston, Mass.,	S. P. Wardwell, Ea. Oxford	
995			Edwin Chick & Co., Bangor	35.00
1034			Steward Bros., Skowhegan.	35.00
1027	Bowker's Farm and Garden Phosphate	" " " " "	F. L. Butler, Farmington	

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
897	Bowker's Hill and Drill Phosphate......	Bowker Fert. Co., Boston, Mass.,	F. R. Benson, Turner's Cor.	
983			Co-operative Store, Dexter.	$36.00
1003			A. W. Ward, Thorndike...	33.00
852	Bowker's Potato Manure,......................	Bowker Fert. Co., Boston, Mass.,	S. P. Wardwell, Ea. Otisfield	
944			E. E. Parkhurst, Presque I.	38.00
952			Hiram Smith, Houlton.....	38.00
951	Bowker Potato Phosphate......................		Hiram Smith, Houlton.....	36.00
1010	Bowker's Square Brand Bone and Potash......		B. F. Curtis, Richmond....	27.00
1023			J. P. Merrill, Auburn......	27.00
1004	Bowker's Sure Crop Bone Phosphate......		A. W. Ward, Thorndike...	28.00
947	Bradley's Com. Manure for Potatoes and Veg't'le	Bradley Fert., Co., Boston, Mass.,	A. H. Fogg & Co., Houlton.	40.00
979			A. A. Howes, Belfast......	
1038			R. B. Dunning, Bangor....	40.00
873	Bradley's Eureka Seeding Down Fert....		Kendall & Whitney, Portl'nd	26.00
914			Hunter&McMaster, Pittsfield	
915			R. B. Dunning, Bangor.....	26.00
857	Bradley's Potato Manure......................		Hawkes& Whitney, M'c F'lls	36.00
874			Kendall & Whitney, Portl'nd	34.00
906			Cunningham & Sager, Gard.	36.00
913			Hunter&McMaster, Pittsfi'ld	
924			L. K. Cary, Fort Fairfield..	38.00

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
858	Bradley's X. L. Superphosphate	Bradley Fertilizer Co., Boston, Mass.	G. O. Goodwin, Mech. Falls	36.00
872			Kendall & Whitney Portln'd	34.00
905			Cunningham & Sager, Gard'r	36.00
936			Carl Ullric, Caribou	36.00
991			F. L. Ireland, Corinna	34.00
863	Clark's Cove Bay State Fertilizer	Clark's Cove Fertilizer Co., New York, N.Y.,	A. A. Mitchell, Portland	
907			W. M. True, Waterville	36.00
920			D. Morrill, Bangor	34.00
928			L. K. Cary, Fairfield	38.00
848	Clark's Cove Bay State G. G		Benj. Tucker, Norway	30.00
860			A. A. Mitchell, Portland	
921			D. Morrill, Bangor	32.00
903			Robert Pope & Co., Gardin'r	35.00
879	Cleveland Potato Phosphate	Cleveland Dryer Co., Boston, Mass.,	Carleton Bros., Portland	32.00
901			F. P. Morrill, Gardiner	
1022			E. H. Libbey, Auburn	31.50
878	Cleveland Seeding Down Fertilizer		Carleton Bros., Portland	[illegible]0.00
909			F. P. Morrill, Gardiner	
1015			E. H. Libbey, Auburn	26.50
880	Cleveland Superphosphate		Carleton Bros., Portland	32.00
902			Geo. H. Pope, Gardiner	
1016			E. H. Libbey, Auburn	1.50

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
889	Crocker's Corn Phosphate	Crocker Fert. & Chem. Co., Buffalo, N. Y.,	Geo. H. True, Freeport	
976			L. A. Knowlton, Belfast	$36.00
1008			B. F. Curtis, Richmond	36.00
1046	Concentrated Phosphatic Rock	Cumberland Bone Co., Portland,	College Farm, Orono	
849	Cumberland Superphosphate		Benj. Tucker, Norway	32.00
875			Cumb'l'd Bone Co., Portland	30.00
916			R. B. Dunning, Bangor	32.00
917	Cumberland Potato Fertilizer		R. B. Dunning, Bangor	36.00
933			A. L. Haines, Fort Fairfield	36.00
941			W. H. Bragdon, Perham	36.00
942			E. E. Parkhurst, Presque I.	36.00
877	Cumberland Seeding Down Fertilizer		Cumb'l'd Bone Co., Portland	25.00
966			L. A. Knowlton, Belfast	
996			E. Conforth, Thorndike	26.00
892	Dirigo Fertilizer	Sagadahoc Fertilizer Co.,	Sag. Fert. Co., Bowdoinham	25.00
911			A. R. Smith, Clinton	26.00
987			Geo. A. Tibbetts, Corinna	26.00
918	Farrar's Potato Phosphate	F. S. Farrar & Co., Bangor Me.,	Whitney & Cameron, Bangor	34.00
919	Farrar's Superphosphate		Whitney & Cameron, Bangor	32.00
1041			K. Pooler, Stillwater	35.00

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
881, 938, 980, 985	Grass and Grain Fertilizer	E. Frank Coe, New York, N. Y.,	S. H. Fitz, Freeport	
			Morrison & Joy, El'sworth	$29.50
			A. A. Howes, Unity	
			S. L. Small, Dexter	26.00
1039, 1042, 1044	Great Eastern General Corn Manure	Great Eastern Fertilizer Co.,	Loud & Wilson, E. Newport	34.00
			K. Pooler, Stillwater	35 00
			H. H. Page. Orono	35.00
1040, 1043	Great Eastern General Potato Manure		Loud & Wilson, E. Newport	34.00
			H. H. Page, Orono	35.00
862, 922	Great Planet Manure	Clark's Cove Fertilizer Co., New Bedford, Mass.	A. A. Mitchell, Portland	
			D. Morrill, Bangor	36.00
999	Ground Bone and Potash	E. Frank Coe, New York.,	Geo. E. Bryant, Knox	
856, 885, 912, 927	High Grade Amm. Bone Superphosphate		G. O. Goodwin, Mech'c F'lls	33.00
			S. H. Fitz, Freeport	
			Hunter&McMaster Pittsfield	35.00
			L. K. Cary, Ft. Fairfield	38.00
847, 861, 908, 923	King Phillip Alkaline Guano	Clark's Cove Fertilizer Co.,	Benj. Tucker, Norway	30.00
			A. A. Mitchell, Portland	
			W. M. True, Waterville	31.00
			D. Morrill, Bangor	30.00
954	May Flower Fertilizer	John S. Reese & Co., Baltimore, Md.,	Smith & Van Allen Houlton	33.00
955	New England Favorite		Smith & Van Allen, Houlton	35.00

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
888	New Rival Amm. Superphosphate	Crocker Fert. & Chem. Co., Buffalo, N. Y.,	Geo. H. True, Freeport	
977	" " " "	" " " " " "	L. A. Knowlton, Belfast	$30.00
1013	Nobsque Guano	Pacific Guano Co., Boston, Mass.,	Carleton Bros., Portland	26.00
984	Original Bay State Bone Superphosphate	J. A. Tucker & Co., Boston, Mass.,	E. G. Libbey, Dexter	33.00
998			E. Cornforth, Thorndike	33.00
1020			N. Dayton Bolster, Paris	34.00
978	Original Coe's Superphosphate	Bradley Fertilizer Co., Boston, Mass.,	A. A. Howes, Belfast	
1036			Steward Bros., Skowhegan.	
1005	Otis Superphosphate	S. G. Otis, Hallowell, Me.,	Willis, Kittredge, Cottle & Co. Hallowell	
1018			Chas. E. Freeman, Norway.	31.50
953	Pilgrim Fertilizer	John S. Reese & Co., Baltimore,	Smith & Van Allen, Houlton	30.00
926	Potato Fertilizer, High Grade	E. Frank Coe, New York,	L. K. Cary, Ft. Fairfield	38.00
948			W. G. Brown, Houlton	35.00
890	Potato Hop and Tobacco Phosphate	Crocker Fert. and Chem. Co., Buffalo, N Y.,	Geo. H. True, Freeport	
929			L. K. Cary, Ft. Fairfield	38.00
946			R. J. Smith, Presque Isle	36.00
1021	Plymouth Rock Fertilizer	Ames Fertilizer Co., Peabody, Mass.,	J. V. McKinney, Auburn	

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
881	Quinnipiac Phosphate	Quinnipiac Co., Boston,	Carleton Bros., Portland	$36.00
895			Wm. Grant, Randolph	
962			N. S. Kent, Bucksport	37.00
964			L. A. Knowlton, Belfast	35.00
882	Quinnipiac Potato Manure	" " "	Carleton Bros., Portland	36.00
896			D. G. Given, Turner's Cor.	
960			N. S. Kent, Bucksport	37.00
973			L. A. Knowlton, Belfast	36.00
883	Quinnipiac Seeding Down Manure	" " "	Carleton Bros., Portland	32.00
961			N. S. Kent, Bucksport	30.00
967			L. A. Knowlton, Belfast	30.00
956	Reeves' Potato Special Corn Manure	John S. Reese & Co., Baltimore, Md.,	Smith & Van Allen, Houlton	40.00
899	Royal Bone Phosphate	Williams & Clark Co., Boston,	F.W.Chadwick,N.Whitefi'ld	
970			L. A. Knowlton, Belfast	30.00
1025			E. W. Verrill, Auburn	
893	Sagadahoc Superphosphate	Sagadahoc Fertilizer Co.,	Sag. Fert. Co., Bowdoinham	30.00
910			A. R. Smith, Clinton	30.00
989			Geo. A. Tibbetts, Corinna	32.00
871	Soluble Pacific Guano	Pacific Guano Co., Boston,	Carleton Bros., Portland	35.00
904			Robert Pope & Co., Gardiner	35.00
909			W. M. True, Waterville	34.00
945			E. L. Tarbell, Presque Isle	35.00
993	Soluble Pacific Special Potato Manure	" " " "	D. Morrill, Bangor	

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
884	Soluble Pacific Special for Tobacco and Potatoes	Pacific Guano Co., Boston,	Carleton Bros, Portland....	$35.00
972			L. A. Knowlton, Belfast....	38.00
1045	South Carolina Rock (Lowe)...................	Bowker Fertilizer Co., Boston,	College Farm, Orono.......	
891	Special Potato Fertilizer.......................	Sagadahoc Fertilizer Co., Bowdoinham,	Sag. Fert. Co., Bowdoinham	34.00
932			A. L. Haines, Ft. Fairfield.	36.00
988			Geo. A. Tibbetts, Corinna..	35.00
1019			C. B. Cunningham & Son, Norway..	36.00
940			E. A. Goodwin, Caribou...	36.00
925	" " "	E. Frank Coe, New York,	L. K. Cary, Ft. Fairfield...	40.00
937			Irving & Ricker, Caribou..	38.00
949			W. G. Brown, Houlton....	35.00
864	Standard A Brand, Seeding Down.............	Standard Fertilizer Co., Boston..............	Carleton Bros., Portland...	30.00
968			L. A. Knowlton, Belfast...	30.00
1000			S. S. Downs, Thorndike....	27.00
850	Standard Fertilizer............................		C.B.Cummings&SonNorw'y	32.00
865			Carleton Bros., Portland...	32.00
930			Thurlow, Richards & Co., Ft. Fairfield..	38.00
939			S. S. Hackett, Caribou.....	38.00
866	Standard Guano.............		Carleton Bros., Portland...	30.00
931			Thurlow, Richards & Co., Ft. Fairfield..	35.00
938			S. S. Hackett, Caribou.....	35.00

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
992 1012	Standard Potato Fertilizer	Standard Fertilizer, Boston, Mass.,	D. Morrill, Bangor Carleton Bros., Portland	
969 994 1011	Standard Superphosphate		L. A. Knowlton, Belfast D. Morrill, Bangor Carleton Bros., Portland	$37.00 32.00
1001 1006 1030	Stockbridge Manure for Corn	Bowker Fertilizer Co., Boston,	A. W. Ward, Thorndike B. F. Curtis, Richmond W. H. Keith, Winthrop	40.00 41.00 40.00
1032	Stockbridge Manure for Onions		W. M. True, Waterville	42.00
851 898 934 943 950	Stockbridge Manure for Potatoes		S. P. Wardwell, E. Otisfield F. R. Benson, Turner's Cor. A. L. Haines, Ft. Fairfield. E. E. Parkhurst. Presque I. Hiram Smith, Houlton	 42.00 42.00 40.00
1002	Stockbridge Manure for Roots		A. W. Ward, Thorndike	40.00
1024	Stockb'ge Man. for Small Fruits and Strawberries		J. P. Merrill, Auburn	42.00
982 1032	Stockbridge Manure for Top Dressing		Co-operative Store, Dexter. Wm. True, Waterville	40.00 42.00
1007	Stockbridge Manure for Vegetables		B. F. Curtis, Richmond	41.00
1014	Sulphur and Tobacco Lawn Fertilizer	F. C. Sturtevant, Hartford, Conn.,	W. C. Sawyer, Portland	50.00
854 870 965	Williams & Clark Potato Phosphate	Williams & Clark Fertilizer Co., Boston,	S. D. Edwards, Oxford Carleton Bros., Portland L. A. Knowlton, Belfast	36.00 36.00 35.00

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Phosphoric Acid. Reverted %	Phosphoric Acid. Insoluble %	Phosphoric Acid. Total %	Phosphoric Acid. Available %	Potash %	Station Valuation. Value of nitrogen $	Station Valuation. Value of phosphoric acid $	Station Valuation. Value of potash $	Station Valuation. Total valuation $
997	Alkaline Bone	9.45	1.24	6.45	2.53	3.44	12.42	8.98	1.86	3.97	14.59	1.96	20.52
855	Americus Amm. Bone Superphosphate	13.60	2.65	6.26	3.80	1.22	11.28	10.06	1.77	8.48	15.20	1.59	25.27
869	Americus Corn Phosphate	13.45	2.29	7.39	2.71	1.82	11.92	10.10	1.57	7.33	15.60	1.41	24.34
957	Amm. Bone Superphosphate (Standard Grade)	8.90	1.70	5.81	2.50	4.39	12.70	8.31	1.21	5.44	13.97	1.27	20.68
859	Bay State Fertilizer for Seeding Down	15.20	1.25	5.91	2.65	1.84	10.40	8.56	2.28	4.00	13.31	2.05	19.36
990	B. D. Sea Fowl Guano	13.05	2.32	7.25	2.59	1.80	11.64	9.84	1.62	7.42	15.22	1.46	24.10
853	Bowker's Amm. Bone Fertilizer	11.00	2.30	6.77	1.58	4.72	13.07	8.35	2.57	7.36	14.25	2.31	23.92
1027	Bowker's Farm and Garden Phosphate	10.70	2.22	6.72	1.15	4.54	12.41	7.87	2.34	7.10	13.51	2.11	22.72
897	Bowker's Hill and Drill Phosphate	11.95	2.70	7.16	2.78	2.42	12.36	9.94	2.17	8.64	15.60	1.95	26.19
852	" Potato Manure	7.70	2.53	4.04	3.63	7.11	14.78	7.67	7.14	8.10	13.98	6.43	28.51
951	" " Phosphate	11.95	2.47	6.46	1.47	4.04	11.97	7.93	2.48	7.90	13.37	2.23	23.50

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Phosphoric Acid. Reverted %	Phosphoric Acid. Insoluble %	Phosphoric Acid. Total %	Phosphoric Acid. Available %	Potash %	Station Valuation. Value of nitrogen $	Station Valuation. Value of phosphoric acid $	Station Valuation. Value of potash $	Station Valuation. Total valuation $
1010	Bowker's Square Brand Bone and Potash	5.60	1.68	2.19	3.78	12.50	18.47	5.97	2.14	5.38	13.57	1.93	20.88
1004	" Sure Crop Bone Phosphate	13.25	1.02	8.80	1.50	2.85	13.15	10.30	1.48	3.26	16.44	1.33	21.03
947	Bradley's Complete Manure for Potatoes and Vegetables	11.10	3.55	6.84	2.15	1.94	10.93	8.99	6.30	11.72	14.04	5.67	31.43
873	" Eureka Seeding Down Fertilizer	9.10	2.30	3.12	2.25	6.55	11.92	5.37	2.26	7.36	10.45	2.03	19.84
857	" Potato Manure	12.55	2.75	3.95	2.02	2.56	8.53	5.97	5.04	8.80	9.77	4.54	23.11
858	Bradley's X. L. Superphosphate	12.10	2.79	7.04	2.78	2.29	12.11	9.82	2.14	8.93	15.37	1.93	26.23
863	Clark's Cove Bay State Fertilizer	13.70	2.54	6.58	3.19	1.48	11.25	9.77	1.92	8.13	14.93	1.73	24.79
848	" " " " G. G	13.25	2.34	7.04	2.99	1.79	11.82	10.03	2.10	7.49	15.47	1.89	24.85
879	Cleveland Potato Phosphate	13.18	2.27	7.23	2.11	1.96	11.30	9.34	2.91	7.26	14.57	2.62	24.45
878	Cleveland Seeding Down Fertilizer	10.65	1.82	4.39	2.15	4.59	11.13	6.54	2.10	5.82	11.43	1.89	19.14
880	Cleveland Superphosphate	13.20	2.28	6.82	2.48	2.35	11.65	9.30	2.26	7.30	14.64	2.03	23.97

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Reverted %	Insoluble %	Total %	Available %	Potash %	Station Valuation. Value of nitrogen $	Value of phosphoric acid $	Value of potash $	Total valuation $
889	Crocker's Corn Phosphate	11.45	2.21	7.04	2.22	2.47	11.73	9.26	1.75	7.07	14.66	1.57	23.30
1046	Concentrated Phosphate	5.20			32.93	12.55	45.48	32.93			51.12		51.12
849	Cumberland Superphosphate	12.55	2.48	6.60	2.71	2.19	11.50	9.31	2.19	7.94	14.57	1.97	24.48
917	" Potato Fertilizer	12.35	2.18	6.82	2.87	1.27	10.96	9.69	2.45	6.98	14.76	2.20	23.94
877	" Seeding Down Fertilizer	14.65	1.76	4.14	2.05	2.56	8.75	6.19	.95	5.63	10.10	.85	16.58
892	Dirigo Fertilizer	6.32	3.04	.63	.65	5.33	6.61	1.28	4.19	9.73	3.98	3.77	17.48
918	Farrar's Potato Fertilizer	12.85	2.75	7.06	2.47	1.77	11.30	9.53	4.44	8.80	15.69	3.99	28.48
919	Farrar's Superphosphate	13.30	2.57	6.93	2.22	2.37	11.52	9.15	2.06	8.22	14.45	1.85	24.52
887	Grass and Grain Fertilizer	10.75	.63	5.33	3.90	3.93	13.16	9.23	1.25	2.02	15.02	1.19	18.23
1039	Great Eastern General Corn Manure	14.32	3.01	3.61	5.61	.91	10.13	9.22	2.26	9.63	13.62	2.03	25.28
1040	" " " Potato Manure	14.30	2.45	3.68	5.84	.93	10.45	9.52	3.87	7.84	14.07	3.48	25.39

RESULTS OF ANALYSES.

Station Number.	Brand.	% Moisture	% Nitrogen	Phosphoric Acid. % Soluble	% Reverted	% Insoluble	% Total	% Available	% Potash	Station Valuation. $ Value of nitrogen	$ Value of phosphoric acid	$ Value of potash	$ Total valuation
862	Great Planet Manure	11.00	3.45	6.65	2.03	1.48	10.16	8.68	6.78	11.40	13.40	5.42	30.22
999	Ground Bone and Potash	6.40	1.40		2.13	9.72	11.85	2.13	3.35	4.48	6.87	3.01	14.36
856	High Grade Amm. Bone Superphosphate	8.40	2.12	7.50	2.20	2.11	11.81	9.70	2.10	6.96	15.17	2.12	24.25
847	King Phillip Alkaline Guano	14.15	1.70	5.58	2.59	2.42	10.59	8.17	2.90	5.44	12.95	2.61	21.00
954	Mayflower Fertilizer	15.62	1.63	2.78	7.57	.90	11.25	10.35	1.59	5.22	15.12	1.43	21.77
955	New England Favorite	14.47	1.86	3.44	6.78	1.27	11.49	10.22	1.14	5.95	15.16	1.03	22.14
888	New Rival Amm. Superphosphate	12.70	1.31	5.96	2.64	3.22	11.82	8.60	1.55	4.19	13.91	1.39	19.49
1013	Nobsque Guano	13.90	1.29	6.33	2.25	1.65	10.23	8.58	2.47	4.13	13.30	2.22	19.65
984	Original Bay State Bone Superphosphate	11.27	2.87	2.05	5.41	3.66	11.12	7.46	4.07	9.18	12.10	4.21	25.49
978	Original Coe's Superphosphate	13.22	2.29	6.97	2.15	3.03	12.15	9.12	1.61	7.33	14.67	1.45	23.45
1005	Otis Superphosphate	13.35	2.87	6.84	2.90	2.30	12.04	9.74	2.31	9.18	15.24	2.08	26.50

RESULTS OF ANALYSES.

Station Number.	Brand.	% Moisture	% Nitrogen	Phosphoric Acid. % Soluble	% Reverted	% Insoluble	% Total	% Available	% Potash	Station Valuation. $ Value of nitrogen	$ Value of phosphoric acid	$ Value of potash	$ Total valuation
953	Pilgrim Fertilizer	15.36	1.16	2.17	6.51	1.23	9.91	8.66	1.70	3.71	12.58	1.53	18.09
926	Potato Fertilizer, High Grade	10.10	2.26	5.54	2.00	2.05	9.59	7.54	5.13	7.23	11.93	5.39	24.55
890	Potato, Hop and Tobacco Phosphate	12.30	2.11	6.38	2.61	1.96	10.95	8.99	2.87	6.75	14.00	2.58	23.23
1021	Plymouth Rock Fertilizer	11.75	2.93	5.03	5.43	.70	11.16	10.46	3.52	9.36	15.42	3.57	28.37
881	Quinnipiac Phosphate	14.00	2.74	6.84	3.01	1.50	11.35	9.85	1.73	8.77	15.08	1.56	25.41
882	" Potato Manure	11.95	2.69	4.52	1.58	2.14	8.24	6.10	5.34	8.61	9.85	4.81	23.27
883	" Seeding Down Manure	14.50	1.20	6.41	2.10	1.84	10.35	8.51	2.12	3.84	13.29	1.91	19.04
956	Reeves' Potato Special Concentrated Manure	14.85	2.97	2.72	5.02	.55	8.29	7.74	8.45	9.50	11.05	7.60	28.15
899	Royal Bone Phosphate	15.00	1.26	5.87	2.15	2.16	10.18	8.02	2.26	4.03	12.67	2.03	18.73
893	Sagadahoc Superphosphate	12.50	2.81	6.92	2.10	1.19	10.21	9.02	3.00	8.99	13.80	2.70	25.49
871	Soluble Pacific Guano	14.50	2.36	6.83	3.43	.84	11.10	10.26	2.03	7.55	15.38	1.83	24.76

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Reverted %	Insoluble %	Total %	Available %	Potash %	Station Valuation. Value of nitrogen $	Value of phosphoric acid $	Value of potash $	Total valuation $
993	Soluble Pacific Special Potato Manure	13.40	2.87	4.11	1.59	1.96	7.96	6.00	5.06	9.18	9.62	4.55	23.35
884	" " " for Tobacco and Potatoes	12. 0	2.25	7.25	2.22	1.78	11.25	9.47	3.13	7.25	14.69	2.82	24.71
1045	South Carolina Rock	1.00			1.52	23.82	25.34	1.52			11.66		11.66
891	Special Potato Fertilizer, Sagadahoc	11.50	2.84	5.17	1.81	1.00	7.98	6.98	7.86	9.28	10.68	7.36	27.32
925	Special Potato Fertilizer (Coe's)	8.80	1.78	7.01	2.09	2.21	11.31	9.10	3.46	5.70	14.32	3.66	23.68
864	Standard A Brand Seeding Down	10.60	1.29	6.61	2.68	2.23	10.08	7.85	1.49	4.13	12.39	1.34	17.86
850	Standard Fertilizer	13.90	2.34	5.17	2.93	2.11	11.65	9.54	2.07	7.48	14.85	1.86	24.19
866	" Guano	15.10	1.33	4.76	2.64	2.26	9.66	7.40	2.32	4.23	11.74	2.09	18.09
99[illegible]	" Potato Fertilizer	13.55	2.14	7.32	2.30	1.48	11.10	9.62	2.62	6.85	14.79	2.36	24.00
969	" Superphosphate	13.70	2.65	6.54	3.19	1.71	11.44	9.73	2.07	8.48	14.95	1.86	25.29
1001	Stockbridge Manure for Corn	10.77	2.94	6.64	2.94	3.43	13.01	9.58	4.46	9.41	15.43	4.01	28.85

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Reverted %	Insoluble %	Total %	Available %	Potash %	Station Valuation. Value of nitrogen $	Value of phosphoric acid $	Value of potash $	Total valuation $
1032	Stockbridge Mannre for Onions	10.50	3.50	5.83	2.50	2.62	11.00	8.38	5.89	11.20	13.37	5.90	29.87
851	" " " Potatoes	9.02	3.46	6.35	2.55	2.33	11.23	8.90	6.06	11.07	14.02	5.45	30.54
1002	" " " Roots	4.80	5.06	1.97	2.23	7.38	11.58	4.20	7.12	16.19	9.02	6.40	31.61
1024	" " " Small Fruits and Strawberries.	8.25	2.51	6.14	2.24	3.59	11.97	8.38	9.36	8.03	13.79	10.22	32.04
982	" " " Top Dressing	4.45	4.99	1.28	3.66	7.48	12.42	4.94	5.95	15.97	10.03	5.35	31.35
1007	" " " Vegetables	10.15	3.70	5.01	3.09	2.56	10.66	8.10	6.69	11.84	12.85	6.01	30.70
1014	Sulphur and Tobacco Lawn Fertilizer	13.50	2.12			.88	.88		7.05	6.78	.33	7.75	14.86
854	Williams & Clark Potato Phosphate	12.07	2.85	4.35	1.73	2.38	2.38	7.17	5.43	9.12	9.89	4.89	23.09

OBSERVATIONS ON THE FERTILIZER INSPECTION OF 1892, AND REMARKS ON METHODS OF BUYING PLANT FOOD.

In the case of sixty-four brands of fertilizers analyzed, the average selling price as given to the Station Agent was $34.08. The average station valuation of the same brands was $24.07, or $10 less than the selling price.

The station valuation is the same for which the fertilizing ingredients in one ton can be bought in the large markets in a condition ready for use, consequently in 1892 it is costing the farmer $10 per ton or forty per cent. of the retail price in Boston, for instance, to have the goods placed at his door. Perhaps it may be said that some manufacturers are furnishing plant food more cheaply. In the case of seventeen brands sold by two leading manufacturers, the average selling price is $36.38 and the average station valuation $27.05, a difference of $9.33, or 34.5 per cent. of the cost in the market.

It appears then, that even with the manufacturers most largely patronized, there is a margin of over $9.00 between what farmers are actually paying for a ton of superphosphate and the cost of the same amount of plant food in unmixed goods when bought in the large markets. It certainly does not cost $9.00 for freight and mixing. The other items of expense are agents' commissions, credit, etc., and these might be saved by a change in business methods.

This subject has been extensively studied and discussed by the New Jersey Experiment Station, and the following admirable comments by Mr. Voorhees, chemist of the station, are of interest to farmers in general.

"The principal points which have been shown are—1. That the nitrogen, phosphoric acid and potash in raw or unmixed materials can be bought at a less cost per pound than the Station's valuations; and 2. That the cost of the same elements in mixed fertilizers is at least 25 per cent. greater than Station's valuations. The difference between these two methods of buying would amount on the basis of last year's sales to over $336,000. (For New Jersey.) This sum is consumed not in manufacturers'

profits alone, as some suppose, but in the transportation of a vast amount of absolutely worthless material, in agents' commissions and in credit.

There are two classes of farmers who claim that it does not pay to buy the unmixed or incomplete materials: First, those who use very small quantities; and, second, those who act as selling and advertising agents. In the first case less favorable terms are quoted for unmixed materials, and the expenses of freight and handling are proportionately increased, thus adding materially to the cost of actual fertilizing elements. In the second case specific brands are bought direct from the manufacturer in large lots at low rates for cash, thus saving in freight, commission and credit upon personal supplies. The majority of farmers, however, especially those who make farming their sole business, do not belong to either of these classes, and hence these arguments lose their force, though not their influence, on such farmers as are not progressive and do not study closely the matter of economical buying. Still, if manufacturers would treat all buyers as they do their agents and sell to them direct, and farmers could be made to realize the importance of co-operation and of cash purchases, the trade in complete fertilizers would be more satifactory to both producer and consumer. Under present conditions, however, the evidence gathered by the Station is manifestly in favor of the buying of unmixed materials and applying direct, as needed, or mixing to suit the varied needs of crop and soil."

Among the causes which should receive emphatic mention as producing the high prices for mixed fertilizers sold by agents, is the credit system, and for this the farmer is himself largely responsible. A cash system would make a saving of so large a per cent. of the cost of fertilizers as to render it profitable for farmers to hire money at six per cent. in order to pay down for their goods. Still further advantage would be secured by co-operation in the buying of large quantities.

Unmixed fertilizers such as plain superphosphates, nitrate of soda and muriate of potash have been mentioned as furnishing plant food more cheaply than the mixed goods, but this is not necessarily the case. It so happens that the former materials are the ones which can be purchased without the intervention of the travelling and local agents, whose interests must be protected by the manufacturer, and these are the goods to which the more

economical method of buying can more easily be applied. As Mr. Voorhees suggests, the common brands of superphosphate could doubtless be obtained on just as favorable terms, provided a change could be made to direct sales of large quantities for cash.

If farmers would give this matter immediate practical attention, they would be more certain to secure prompt and important financial advantages than by the long drawn out discussions over tax and tariff reforms, however important these may be.

The disadvantages of the present method by which our farmers are largely obtaining their fertilizers may be summarized as follows:

(1) It is a costly system of selling due to the large expense for agents and the great loss on credits.

(2) It is a system which unfortunately seems to be accompanied by so many unfair arguments and so much of distortion of facts that the farmer is, to some extent, hindered rather than aided in gaining clear ideas of true facts.

(3) And so this is a system which leads farmers to consider chiefly the rival claims of competing manufacturers rather than to study his own needs and then to buy such plant food as is adapted to his wants.

If farmers are to purchase commercial plant food, great advantages would result in a change to the following system:

(1) The buying of plant food as such under proper names, and thus avoid the confusion and uncertainty attending the purchase of an ever increasing number of brands whose names mean little or nothing.

(2) The purchase of fertilizers in large quantities for cash.

MISCELLANEOUS ANALYSES.

835. *Muck* from I. O. Winslow, St. Albans.

841 and 842. *Mucks* from E. E. Light, Burkettsville.

	835		841		842	
	Original condition.	Water-free.	Original condition.	Water-free.	Original condition.	Water-free.
Water	77.52	——	80.66	——	79.54	——
Ash and Sand	4.30	19.15	1.49	7.70	7.04	34.43
Potash	.03	.14	.02	.08	.04	.20
Phosphoric Acid	.24	1.08	.10	.54	.19	.96
Nitrogen	.38	1.70	.42	2.16	.34	1.67

When received at the station samples of muck contained so much water that it is necessary to dry them before they can be properly pulverized for analysis. The results obtained are recalculated for the original content of water and also, for purposes of comparison, to a water-free basis. The first figures are, of course, of most interest to the farmer, as they represent more nearly the condition of the muck as it is ordinarily used for agricultural purposes.

672. *Feldspar.*—From Cumberland Bone Co. Potash 12.07 per cent. A typical orthoclase feldspar may contain as high as 16.9 per cent. potash. Here, as in most feldspars of the orthoclase variety, a part of the potash is replaced by soda.

676. *Fish Pomace.*—From P. B. Friend, N. Sedgwick. This is said to consist for the most part of the heads of herrings, from a sardine factory. It contains: Water 54.66 per cent., Nitrogen 5.26 per cent., Potash .26 per cent., Phosphoric acid 2.05 per cent.

684. *Sea Weed.*—From H. A. Long, Gt. Beach, Roque Island. Water 76.00 per cent., Nitrogen 1.04 per cent., Phosphoric acid .07 per cent.

834. *Cedar Ashes.*—From Judge Robinson, Houlton. Water 1.52 per cent., Potash 5.09 per cent., Phosphoric acid 1.91 per cent.

843. *Ashes from Burned Muck.*—From Albert Pease, Phillips. This material is largely siliceous, about 95 per cent. being insoluble in hydrochloric acid. It contains traces of phosphoric acid, but not enough to give it any value.

ANALYSES OF CATTLE FOODS.

Certain cattle foods have been sent to the Station for analysis from time to time, the composition of some of which is given below.

CXXXVI. Linseed Meal, sent by Hon. Z. A. Gilbert.

CXXXVII. Feed Flour, " " " " "

CXXXVIII. Flour Sweepings, sent by E. F. Roundy, North Hermon.

CXXXIX. Flour Sweepings, sent by E. F. Roundy, North Hermon.

CXXIII. Pratt's Food, sent by A. C. Chandler, New Gloucester.

Station Number.		Air dry.						Water-free.				
		Moisture.	Ash.	Protein N x 6.25.	Fiber.	Nitrogen free extract.	Fats.	Ash.	Protein N x 6.25.	Fiber.	Nitrogen free extract.	Fats.
CXXXVI	Linseed Meal...	9.03	5.60	39.94	7.28	35.27	2.88	6.15	43.94	8.00	38.77	3.15
CXXXVII	Feed Flour......	7.32	2.82	20.81	1.93	62.44	4.68	3.04	22.44	2 08	67.38	5.05
CXXXVIII	Flour Sweepings	11.33	2.50	10.62	1.89	72.03	1.63	2.82	11.98	2.13	81.23	1.84
CXXXVIX	" "	8.80	15.95	9.19	1.50	59.35	5.21	17.49	10.07	1.64	65.09	5.71
CXXIII	Pratt's Food	12.36	5.79	13.75	5.94	56.80	5.36	6.60	15.69	6.77	64.83	6.11

The above analyses of cattle foods call for no special comment with the exception of Pratt's Food for horses and cattle. There are several weighty reasons why this food should receive careful consideration.

(1) It is sold at the rate of $120 per ton.

(2) Its manufacturers claim that it prevents nearly all of the common diseases and disorderes to which farm animals are subject, that it is, besides, a preventive of certain serious contagious diseases, that it produces richer milk and more of it, that animals fatten quickly when it is fed, and that it gives to horses greater power of endurance.

If the manufacturers of this material have succeeded in combining a food that in its relation to disease has such a high preventive and remedial influence, and in its relation to the nutrition of an animal produces the highly valuable results which appear to be claimed by their circulars, they should be classed among the benefactors of the age. It must be confessed, however, that the

advertised claims of this food exceed the credible and pass into the absurd.

This becomes all the more evident when we consider what the food is. It has received a careful examination at this Station, and while we are not prepared to say that it does not contain minute quantities of substances which we have not discovered, we have become convinced that its composition does not warrant its purchase at any unusual price. The results of our examination are as follows:

(1) The food has the appearance of being chiefly ground bran or shorts and is undoubtedly what it appears to be.

(2) The food contains a small amount of fenugreek, an aromatic seed supposed to have mild medicinal properties.

(3) It contains something less than three per cent. of common salt.

(4) The quantities of any other substances which it may contain are so small as to not be easily discovered. It is the opinion of those examining the food that no other compounds exists in it save those which are the proper constituents of any food.

(5) The analysis of the food gives about the same figures that we should expect from bran or shorts, with a somewhat smaller percentage of protein than these milling products now contain.

Even if it were found that this food is so compounded as to have, under certain circumstances, a positive medicinal effect, this fact would not constitute a good reason why farmers should purchase and feed it indiscriminately. We no longer believe in quack nostrums that will cure all troubles. The course which the intelligent farmer takes to-day in the treatment of diseased animals is to secure the attendance and advice of a competent veterinarian who will administer remedies suitable to the case in hand. As for the prevention of disease it is a common experience that all that is ordinarily necessary is cleanliness, good care and proper and sufficient food. If these conditions do not prevail it is useless for the farmer to attempt to remedy the faults in his management by the use of any advertised cure-all, such as the one under consideration. This food may not possess any injurious properties because of the small amount of unusual constituents which it contains, but in the opinion of the writer its purchase at a price exceeding the ordinary cost of commercial cattle foods is a waste of money.

PRELIMINARY NOTES ON THE SECONDARAY EFFECTS OF POLLINATION.

By W. M. Munson.

The change produced by contact of embryo sac and pollen tube is not confined to the mere vivification of one or more cells; though this is the chief end,—the primary object of all pollination. There are certain secondary effects which are of interest to the botanist and may be of great practical value to the horticulturist.

When there is a difference between male and female parents, the embryo partakes to a greater or less extent of the nature of both parents. In general, this influence is apparent first in the offspring of the cross; but in some instances there appears to be an immediate effect on the ovary or other portions of the female parent. In some cases also, the pollen seems to have a direct stimulating influence on the ovarium, without effecting the impregnation of the ovules. Again, in certain instances the vigor of the plant seems sufficient to develop a marked growth of the ovary in the entire absence of the male element. The form and size of the ovary are often materially affected by the application of different amounts of pollen to the stigma. In some plants more than one embryo is developed in a single ovule, indicating the possibility of superfœtation. These, and other secondary problems arising in connection with the systematic amelioration of cultivated plants, are often of great practical importance.

The following notes can be regarded only as preliminary; as forming a basis from which to start in future work in this direction. Although some of the problems considered have been under discussion for more than a century, they are still unsolved. There has not been sufficient systematic study to warrant the formulation of general laws, and this study must necessarily extend over a long series of years. In the notes are embodied as concisely as may be, the more important results obtained by leading experimenters in this country and in Europe, together with some observations of the writer on the subjects in question.

Special acknowledgement is due to Professor L. H. Bailey of Cornell University, for the use of certain notes and photographs, and for free access to his private library.

I. On the Immediate Influence of Pollen on the Mother Plant.

Even before the sexual theory regarding plant reproduction was commonly accepted, the question of the immediate effect of pollen on the form and character of the female parent received the attention of careful observers. Bradley early gave directions for performing the operation of crossing and wrote: "By this knowledge we may altar the property and taste of any fruit by impregnating the one with the farina of another of the same class; as, for example, a Codlin with a Pearmain, which will occasion the Codlin so impregnated to last a longer time than usual and be of a sharper taste; if winter fruit be fecundated with dust of the summer kinds, they will decay before their usual time."*

In 1745 Benjamin Cook, in a paper before the Royal Philosophical Society,† cited the appearance of russet apples on trees ordinarily producing smooth fruit, and the reverse, as examples of the effect of pollen. Other cases have been frequently noted as proofs of the existence of the same phenomenon.‡ Even at this early date, however, careful experiments undertaken by Thomas Andrew Knight and others, tended to show that the apparent effects might be due to bud variations, or other causes aside from the action of pollen. Knight at this time wrote: "I have in some hundred instances introduced the pollen of one variety of the plum, the pear, the apple, the cherry, the peach, the melon and other fruits into the blossoms of very different and opposite habits, and I have never, (although I have most closely attended to the results) found in any one instance the form, colour, size or flavour of the fruit belonging to such blossoms in any degree whatever changed or affected."§

In 1865 Thomas Meehan opened discussion of the subject in the columns of the Gardener's Monthly, remarking: "For ourselves, without being satisfied that there is any material change in the quality of the fruit, we cannot deny there is some; and there may be much more than we at present imagine. At any rate, we think it may be taken for granted that melons grown near squashes often have a suspicious squashy flavour, that gives some ground for the popular theory of mixing."‖ The suggestion is further made

---

* Bradley, New Improvements in Planting and Gardening, 7th ed. (1739), p. 18.
† Philosophical Trans. 1745.
‡ Trans. Lond. Hort. Soc., V, 65.
§ Trans. London Hort. Soc., V, 67.
‖ Gard. Month., VII, 305.

that if the change be found to occur in squashes, the same law will apply to the whole region of fruit—an assumption which is altogether too broad.

There is evidence which goes to show that within certain limits there is an immediate effect of the male element, but that those limits are quite restricted. As early as 1729 the presence of both white and blue peas in the same pod was observed, when two varieties of the different colors were planted near each other.* This fact has been repeatedly confirmed. In 1822 examples were presented to the London Horticultural Society. A variety known as Blue Prussian was crossed with a white variety. The resultant peas were yellowish-white like the male parent.† Laxton, in 1866, crossed the Tall Sugar Pea which bears thin green pods, with pollen of a purple-podded variety. "The pod resulting was clouded with purple, while one of the peas was of a clear violet-purple tint and another was irregularly clouded with purple." The results, in so far as the changed color of the peas is concerned, were confirmed by Darwin.‡

Crucknell§ cites an instance of apparent immediate influence in case of the pear. A single branch on a Belle Lucrative tree bore a few specimens resembling Vicar or Winkfield. As Vicars were growing near, the conclusion is drawn that the fruits in question were affected by the foreign pollen. There is no reason to suppose, however, that this and the numerous cases of the appearance of russet apples on trees not usually russeted, are other than instances of bud variation, as pointed out by Knight.‖

Of about one hundred artificial pollinations performed by Charles W. Garfield at the Michigan Agricultural College, but three of the crosses showed any variation which could in any way be construed as the effect of pollen. "These were: *First.* Wagener upon Tallman Sweet. There was a modification of flavor quite noticable, the fruit being sub-acid. *Second.* Tallman Sweet upon Astrachan. In this instance there was a manifest change in the color, flavor and shape. The apples were quite mild to the taste, the color was very much modified, and the form was that of a flat apple. *Third.* Tallman Sweet upon Wagener. The modification here was noticable in all the specimens, in flavor and

---

* Philosophical Trans., XLIII, 525.

† Trans. Hort. Soc., V, 234.

‡ An. and Plts. Under Domest., I, 428.

§ Gard. Month., IX, 165.

‖ Trans. London Hort. Soc., V, 67.

color."* I am informed, however, that at the present time Mr. Garfield doubts the influence of pollen in causing the variations here noted.

Professor L. H. Bailey in 1887, performed many crosses with different varieties of apples "and got no effect in any way, not even in season of maturity or in texture."† Similar results were obtained by Crozier in 1888. More than one thousand crosses were made, and they were carefully observed during the season with a view to detecting any immediate effects. "The examination failed to show any differences which could be attributed to the influence of the cross. In several instances different varieties were crossed upon the same tree, but the resulting fruits did not differ materially from each other, or from the remainder of the crop upon the tree."‡

In many species, both wild and cultivated, sports bearing fruit differing from the normal type, are not uncommon. Diœcious plants of this character must necessarily receive pollen from an individual of a different character, but as a rule no effect is observed on the appearance of the fruit of either individual. A single plant of *Mitchella repens*, bearing white berries, was discovered by Mr. Meehan and removed to his grounds. Thus isolated, it produced no fruit, but in the natural state, and fertilized by pollen from the red-berried form, the white fruit was produced in abundance. *Ilex verticillata* as a rule has red berries, but a white-berried form on the grounds of Professor Sargent regularly produced white fruit, although necessarily receiving pollen from the red form.§

On the other hand, instances are cited to show that there is a marked effect on the color of flowers when two varieties of different color are in close proximity. White verbenas, growing by the side of a pink variety are said to have produced striped flowers on the side of the plant next to the pink variety—the other side of the plant retaining the white color.‖ Similar instances of changed color in case of phlox and petunias have come under my own observation, but in each of these cases the plants were so situated that the change could not be construed as due to the influence of pollen.

If pollen exerts a modifying influence on the character of the fruit, we should expect the color of black grapes to be less

* Gard. Month., XVIII, 23, (Jan., 1876.)
† Proc. Am. Pom. Soc., 1887, 22.
‡ Crozier, Bul. 3, Iowa Agr. Expt. Sta., 92.
§ Gard. Month., XXVII, 116.
‖ Berckmans, Am. Agriculturist, July, 1889, 344.

intense if fertilized by pollen from white varieties, than if self-fertilized, or crossed by other dark varieties. That such influence is doubtful, however, is indicated by the work of Goff, of Crozier and others.

In 1886, Goff crossed several varieties of black grapes with pollen from a white variety—the Lady Washington. Other flowers on the same vines were self fertilized. At maturity it was impossible to detect any difference either of color or of flavor between the self-fertilized and the crossed berries of the same variety.* Similar results were obtained by Crozier at the Iowa Experiment Station in 1888.†

The cotton plant furnishes an instance in which there is apparently unmistakable evidence of the immediate effect of foreign pollen. In 1890, at the Georgia Experiment Station, flowers of upland cotton, *Gossypium Barbadense*, were crossed with pollen from common Okra, *Hibiscus esculentus*. Apparently perfect bolls of cotton were formed, but in every instance the seed failed to germinate when planted. The reciprocal cross resulted in apparently normal Okra seeds, but the offspring varied from the normal in time of flowering and fruiting.‡ In 1891 the work was repeated, and Director R. J. Redding in a private letter to the writer reports, "bolls of cotton, the result of cotton blooms pollenized with Okra pollen this year, in which one and sometimes two of the carpels contained a very small quantity of lint adhering to the seed while the other divisions of the ovary were abortive."

It was early observed§ that there is an immediate visible effect of foreign pollen on corn, extending in many cases even to the receptacle, and the repeated confirmations by Crozier, Sturtevant,‖ Kellerman,¶ Tracy** and others would leave little doubt as to the accuracy of the observations.

That there is a difference in varieties, in the readiness with which the influence of pollen is shown, is altogether probable. Sturtevant lays down the general proposition: "Under the conditions of ordinary seed, maize does not in general show the effects of current cross-fertilization, the exception being the sweet corns which exhibit the influence of current foreign pollen very readily."†† The proposition is based on the study of about one

* 5th Rep. N. Y. Agr. Exp. Sta., 180.
† Agr. Sci., II, 319.
‡ Expt. Sta. Record, III, 135.
§ Philosophical Trans., XLVII, 206.
‖ 3rd Rep. N. Y. Exp. Sta., 148.
¶ 2nd Rep. Kan. Exp. Sta., 288-335, (1889).
** Rep. Mich. Hort. Soc., 1888, 43.
†† 3d Rep. N. Y. Ag. Exp. Sta., 149.

hundred and twenty-five named varieties, including flint, dent, pop, and sweet corns. That the flint and dent varieties often exhibit a change the current year, however, is abundantly proved by the work of the other experimenters referred to; though all agree that the change is most readily seen in sweet corn, and least so in the flint varieties. In this connection, also, Sturtevant makes the statement that "cross-bred corn has a greater tendency to current cross-fertilization than has purely bred corn"*—a condition we should naturally expect from the variable tendency of hybrids and cross-breeds. While there would seem to be no doubt as to the immediate influence of foreign pollen in the case of corn, it is not improbable that what is in reality seminal effect, may sometimes be credited to the immediate action of the foreign pollen.

Darwin cites numerous instances† to prove the existence of an immediate effect of crossing and though some of the examples to which he gave credence are now discredited, many of them are apparently well authenticated.

Seeds of *Matthiola annua* are normally of a light brown color, while those of *M. incana* are violet black; yet *M. annua* crossed by *M. incana* yielded about fifty per cent. of black seeds. Flowers of the orange fertilized by pollen from a lemon tree produced fruit bearing a longitudinal stripe of peel having the color, flavor and other characters of the lemon. Recent observations in this country and in Europe would appear to confirm the statements regarding citrus fruits.‡ Sabine§ cites an instance in which the form of the ovary of *Amaryllis vittata* was altered by the application of foreign pollen; while Maximowicz made reciprocal crosses between *Lilium bulbiferum* and *L. davuricum* and found "each species produced fruit almost identical with the pollen bearing species."‖ Fritz Müller crossed *Cattleya Leopoldi* by *Epidendron cinnabarianum*, and obtained a marked change in the form of the seeds.¶

Rhododendron dalhousiæ crossed by *Rhododendron Nutallii* is cited by Darwin as an example of the increased size of ovary resulting from the action of foreign pollen, while *Arabis blepharophylla* crossed by *A. Soyeri* produced pods larger than either parent species.** Darwin also gives credence to the story of the St.

* 3rd Rep. N. Y. Ag. Exp. Sta., 149.
† An. and Plts. Under Domest., I, 428 et seq.
‡ See Repts. Am. Pom. Soc., 1889 and 1891.
§ Trans. Lond. Hort. Soc., V, 69.
‖ Darwin, An. and Plts. Under Domest., I, 431.
¶ Ibid.
** Ibid, 432.

Valery apple, the stamens of which are abortive, and being artifically pollinated, the fruits are said to differ from one another in size, flavor and color, resembling in character the various kinds by which they have been fertilized.*

In the cultivation of pistillate varieties of strawberries, it is usually considered necessary to set some variety with well developed stamens in the immediate vicinity to furnish the pollen requisite to the fertilization of seeds, and consequent development of the receptacle. It is believed by many growers that the character of these pistillate varieties may be varied at will, by using different varieties for the male parent. In other words, it is believed that there is an immediate effect of the male element in determining the time of maturity, the color, the shape, and even the flavor of the receptacle of the variety crossed. If this theory be based on fact, it is of no small practical importance. If it were true, that in all cases, or that as a rule, the fruit partakes of the character of the male parent, there could be no fixed character to any pistillate variety. But will the facts warrant the assumption that this immediate effect in the case of strawberries is by any means universal, if common? Personally I have conducted no work bearing upon this point, but several experiments have been performed by careful observers, and the results obtained by them are of interest in this connection. The results as published differ considerably, but in general, the weight of authority goes to show that the receptacle is not materially affected by the male element.

At the meeting of the American Pomological Society in 1885, extended and spirited discussions of this subject were held. Professor W. R. Lazenby of the Ohio Experiment Station, had found the influence of the male element decidedly manifest. When blossoms of Crescent were fertilized by pollen from Downing, Vick, or Sharpless, the characteristic shape, texture and other qualities of the male used, were impressed on the receptacle to such an extent that it was possible to determine the male parent from the general appearance of the crop.† A repetition of these experiments the following season, however, failed to give any marked results.‡

A. S. Fuller who has made a careful study of the subject since 1859, claims to have obtained very marked indications of an

* Darwin, An. and Plts. Under Domest I, 432.
† Proc. Am. Pom. Soc., 1885, 66.
‡ Rep. Ohio Exp. Sta., 1885, 107.

immediate directing influence on the form and size of the receptacle.* Mr. Fuller attributes this apparent influence to the direct action of the pollen in stimulating the growth of ovary or receptacle without reference to the fertilization of the ovules. Admitting the stimulating effect, however—and of this there seems to be but little doubt—does the directing effect necessarily follow?

From an extensive field experiment conducted by Professor T. J. Burrill in 1884, it was found "easy enough to select individual berries conspicuously different from each other, as is always the case, but it was not possible to detect the slightest tendency towards a resemblance to the pollen bearer."† In a similar experiment conducted the following year on the farm of P. M. Angur of Connecticut, like results were obtained.‡

In none of the carefully conducted experiments of Goff and Hunn at the New York Experiment Station, have any immediate effects been discerned. Berries from Crescent blossoms, receiving the pollen of Lennig's White, were not different in color from those fertilized with Wilson or Sharpless pollen. Flowers fertilized on one side by pollen from the white variety, and on the other with Sharpless pollen were symmetrical in form and uniform in color.§ Out of one hundred and sixty-seven successful crosses made by Crozier, there was not an individual instance that pointed to a specific influence of the foreign pollen.||

The nature of cucurbitaceous plants is admirably adapted to show the immediate effects of crossing if such occur. In a mixed plantation many of the flowers on any individual plant, when left to natural processes, would necessarily receive pollen from very different sources. If now, there were an immediate effect of pollen, we should expect to find fruits of very different character on any vine. Such is not the case, however. I have repeatedly looked for this difference, but have never seen it; nor have I observed it when several flowers on the same plant were artificially crossed with pollen from different varieties or species. Crozier¶ and Bailey have repeatedly obtained like results. Bailey, whose crosses of cucurbits run up into the thousands, asserts positively that: "There is no immediate influence whatever, except such as

---

* Proc. Am. Pom. Soc., 1885, 68.
† Proc. Am. Pom. Soc., 1885, 67.
‡ Ibid, 70.
§ 4th Rep. N. Y. Agr. Exp. Sta., (1885), 227; 5th Rep. (1886), 179; also Bul. 24, (N. S.), 330, (1890).
|| Agr. Sci., IV, 287.
¶ Ag. Sci., I, 227.

is due to imperfect development caused by insufficient or impotent pollen."*

In our work with tomatoes and egg plants there has in no case occurred an instance of immediate effect, other than alteration of form due to insufficient pollen. During the past winter numerous crosses and hybridizations of tomatoes have been made. The accompanying photographs of the most violent of these crosses indicate the entire absence of apparent effects.

Figure 1 represents the "Lorillard," crossed by pollen of the "Currant," (*Lycopersicum esculentum* crossed by *L. Pimpinellifolium*). The Lorillard is a smooth, nearly spherical variety, of medium size, and as grown under glass, seldom weighs more than three or four ounces.

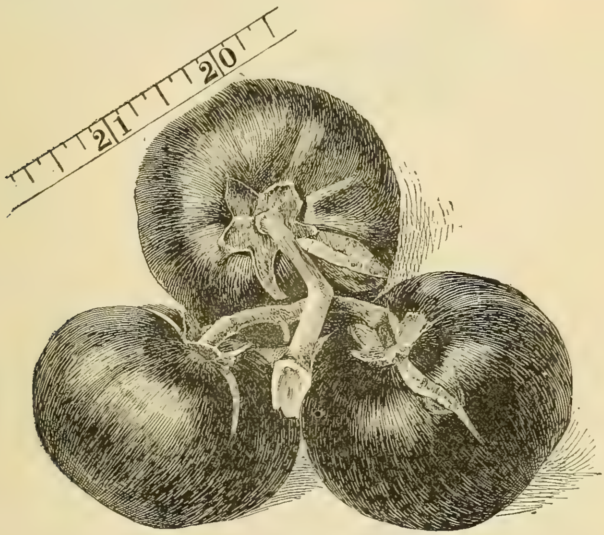


Fig. 1. *Lorillard* × *Currant*.

As will be seen, the fruit is in every respect typical of the Lorillard. The offspring from this cross, however, show unmistakable evidences of the influence of the male parent, both in the habit of the plants and in the character of the foliage and flowers. The fruit also is intermediate between the parents in size and character.

* Bul. 25 Cornell Univ. Exp. Sta., 181, (Dec., 1890).

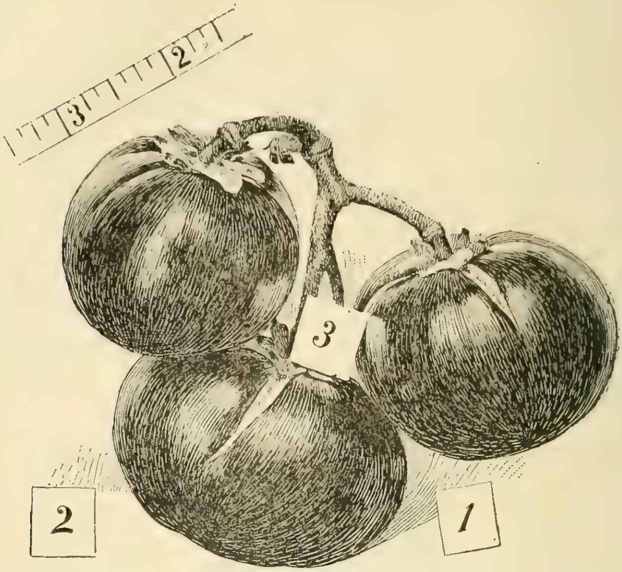


Fig. 2. *Lorillard × No. 1 Lorillard; No. 2, Currant; No. 3 Peach.*

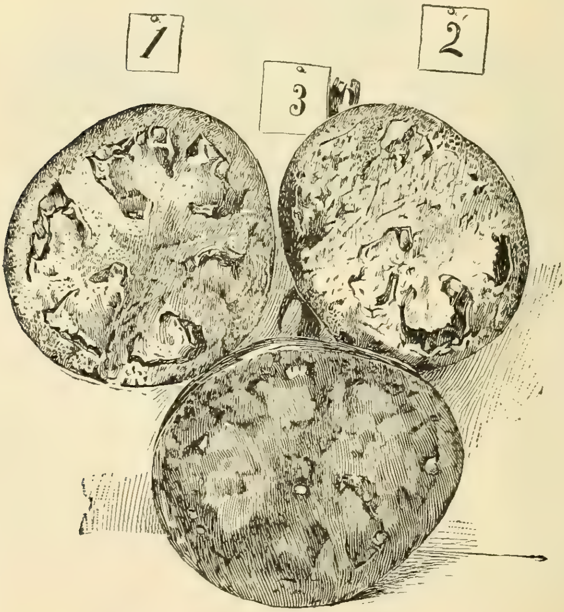


Fig. 3. *Section of Fruits shown in Fig. 2.*

Figures 2 and 3 are from photographs of a cluster in which each fruit has a different male parent. The variety used was the Lorillard. Number 1 received pollen of the same variety, while number 2 was given pollen from the "Currant," and number 3 from the "Peach." As in the previous instance, there is no apparent effect on the form of the fruit; and the seeds gave no indication of the different parentage—all were apparently typical Lorillard seeds.

In the offspring, the differences are very marked. The lines are sharply drawn between the crosses with Peach and Currant, the influence of the respective male parents being very evident, while the Lorillard cross is apparently unaffected by either of the others; indicating that there was no error in the operation, also that there has been no transfer of influence along the short peduncles, as suggested by Lowe.*

In an extended series of experiments with egg plants, conducted for three consecutive years at the Cornell University and the Maine State College, the most widely varying types have been crossed. In no instance, however, has there appeared an immediate effect of the male parent. The little Round White when crossed with pollen from Black Pekin, differed in no respect from other fruits on the same plant. But the offspring of this cross showed very marked variations. The same facts were observed regarding several other crosses.†

As before noted, instances have been reported in which the color of flowers was apparently changed by the action of foreign pollen the current season. An instance of such change has never come under my observation, though I have made numerous crosses of different varieties of Tropæolum, Fuchsia, Silene, Phlox, Petunia, and other ornamental plants.

---

* See page 54.

† Bailey and Munson, Experiences with Egg Plants, Bul. 26 Cornell Ex. Sta., p. 14.

As indicating the range over which the study of the subject has extended, a partial list of the species considered by different observers is given.

Species in which immediate influence of pollen is said to have been observed:	*Species in which no immediate effect appears to occur:*
Amaryllis vittata	Cucumis melo
Arabis blepharophylla	Cucumis sativus
Cattleya Leopoldi	Cucurbita maxima
Citrus aurantium	Cucurbita moschata
Gossypium Barbadense,	Cucurbita pepo
Lilium bulbiferum	Datura Stramonium,
Lilium davuricum	Datura inermis
Matthiola annua	Fragaria Virginiana
Phaseolus vulgaris	Fuchsia sp.
Pisum sativum	Lycopersicum esculentum
Rhododendron dalhousiæ	Mitchella repens
Verbena -sp.	Prunus Americana
Zea Mays	Prinos verticillatus, (Ilex verticillata, Gray)
	Pyrus malus
	Pyrus Torringo
	Pyrus Soulardi
	Vitis labrusca
	Petunia violacea
	Phlox Drummondii
	Silene armeria
	Solanum melongena
	Tropæolum minus

The above lists are doubtless incomplete, and in any case they must necessarily be regarded as tentative. In some of the cases cited, however, the evidence seems indisputable. As will be observed, thirteen species belonging to twelve genera in ten distinct natural orders have shown variation supposed to be due to the influence of pollen of the current generation. On the other hand, twenty-two species belonging to fifteen genera in ten natural orders, have failed to show immediate effects. Of the thirteen species showing immediate influence of pollen, four—the orange, the bean, the pea and Indian corn—are of much value as food plants; while eleven species, or one-half of the whole number considered which have not shown this influence, are also important food plants. These eleven species include many of the leading fruits and vegetables, such as the apple, plum, strawberry, grape, tomato, egg plant, pumpkin, squash and melon. The strongest

evidence both for and against the proposition is obtained from these species of economic importance; but the question is still an open one.

As yet there are no satisfactory data on which to base general conclusions. It would be unwise, at the present time, to assert that the directing influence of pollen does or does not as a rule extend beyond the fertilization of the seed. It seems not improbable that pollen from a vigorous plant may make an imprint of its character on the female organism which shall be different from that of a less vigorous male parent. It is probable, however, that the vigor and inherent vitality of the plant operated upon usually determines whether this be manifested. Some species show apparently unmistakable evidences of the influence of foreign pollen—this is notably the case with peas and Indian corn. On the other hand cucurbitaceous and solanaceous plants seem to resist all foreign influence; while rosaceous plants are in dispute, with the weight of authority tending to show the absence of immediate influence.

II. On the Development of the Ovary without Fecundation of the Ovules.

A common, though not an universal law of reproduction by seed requires fertilization of the ovules as a condition necessary to the development of fruit. It is a matter of common observation that, as a rule, when pollination fails to result in fertilization, or when pollen is withheld, not only the pistil withers, but the entire flower decays and falls. (Pollination is used in the sense of cöition in the animal kingdom, and does not necessarily result in impregnation). Instances are not infrequent, however, which point to a responsive action on the part of the pistil or other portions of the flower receiving pollen, while from an insufficient quantity of pollen, lack of affinity on the part of the species crossed, or some other cause which remains to be determined, fertilization does not occur. Examples of this are specially common in all of our cultivated fruits and vegetables.

About the close of the seventeenth century (1691), Camerarius had observed that a female mulberry tree once bore fruit though no male tree was in its vicinity. The fruits, however, contained only abortive seeds. Plants of *Mercurialis annua* being then

brought under observation, it was noticed that while the fruits were abundant and well filled out, they began to wither when about half ripe and not one produced perfect seed.*

The instance of the mulberry is confirmed by Claypole who cites† a case within his own observation in which a pistillate tree bears fruit abundantly every year though no staminate tree is in the vicinity, and no staminate flowers have been found on the tree itself. The "seeds" in these fruits, as in the other instances, contain no embryos. Whether this is a case of development in the entire absence of pollen, as circumstances would indicate, or whether there may have been a limited supply of pollen at hand, it is evident that the ovaries developed independently of any action on the ovules.

Dr. Masters is authority for the statement that certain varieties of pears habitually produce seedless and coreless fruit.‡ In the same way it is not uncommon to find the capsules of many herbaceous plants fully developed while the seeds are absent. M. Jean Sisley, a well known French horticulturist, found this to occur with great frequency in case of the geraniums and pelargoniums. Of one hundred flowers of *Geranium platypetalum* artificially pollinated, not one produced perfect seeds, and of a large number of capsules sent by another party, nearly all were without seeds.§

Naudin, as a result of his studies of the genus *Cucurbita*, suggested the possibility of a specific effect of pollen in exciting growth of the ovary; and this theory is supported by Focke, who says: "Pollen has two actions on the female organs, one on the seeds, and one in exciting the growth of the fruit."‖ The theory seems plausible, and in view of the many examples of well developed but empty seed pods, it would seem that the stimulating action is alone exerted in some instances. These examples are specially common among peas and beans.

The accompanying photograph, Figure 4, represents the natural size of a Lima bean which failed to develop seeds—the undeveloped ovules may be seen at the right. Similar instances are very common in all varieties of this class.

**R. J. Camerarii Opuscula Botanici Argumenti*, cited by Sachs, Hist. of Bot. 386.
†Rep. U. S. Dept. of Ag. 1887, 318.
‡Nature, XXXV, 12. (Nov. 4, 1886.)
§Gard. Chron. N. S. IV, 654.
‖Focke, Die Pflanzen mischlinge, 447.

Fig. 4. *Lima Bean, Seedless, (Natural Size.)*

According to Hildebrand,* in the case of several orchids the plant's own pollen is necessary for the development of the ovarium; and this development takes place long before the pollen tubes have reached the ovules. So in these cases the pollen acts directly on the ovarium.

Disregard of the fact discovered by Camerarius, but not emphasized by him, that certain diœcious plants occasionally have monœcious individuals, has lead to many erroneous statements regarding the influence of the male element on the ovary. Hemp and Spinach have been cited† as examples of development without fertilization. It is well known, however, that both of these species have monœcious individuals, thus furnishing a source of error in observation. The Muskmelon, *Cucumis melo*, is another instance in point. This fact first attracted my attention when attempting to perform some artificial hybridizations between *Cucumis melo* and *Cucumis sativus*. The female blossoms on the variety under consideration, "Emerald Gem," were found to bear partially developed stamens. These stamens varied in size and in the amount of pollen produced, but subsequent developments indicated that enough pollen may be produced to secure self-fertilization. At the Cornell University Experiment Station several blossoms of this variety from which foreign pollen was excluded developed apparently normal fruits. In these cases of probable self-fertilization, however, there were no perfect seeds.

Darwin cites, on the authority of Dr. Hooker, an instance of the development of the ovarium of a certain orchid—*Bonatea speciosa*—as a result of simple mechanical irritation of the stigma. ‡ So far as I am aware, this observation has never been verified,

*Botanische Zeitung, No. 44 et. seq. Oct. 30, 1863, and Aug. 4, 1865—cited by Darwin, An. and Plts. Under Domest. I, 434.

†Le Maout and De Caisne, System of Botany, 152; also Spallanzani, quoted by Sachs, Hist. of Bot. 424.

‡An. and Plts. Under Domest, I, 434.

and it is questionable, in view of the facts here considered, whether the development would not have been as complete in the absence of the irritation.

The fact that in growing English forcing cucumbers for market, gardeners never practice artificial pollination, as is necessary with the varieties commonly grown in this country, raised the question as to whether any pollen is required, and what proportion of the fruits would develop without fertilization. Several different varieties have been under consideration at different times. In case of the "Telegraph," a long slender variety, more than twenty blossoms before expanding were covered with paper bags —thus preventing all possibility of the access of pollen. Out of this number but two developed fruits. These were typical in form and of average size—being about sixteen inches long and two and one-half inches in diameter. They contained a large number of partially developed ovules—some of them 3-8 inch long—extending nearly the whole length of the fruit. There were no perfect seeds, however, as shown by Figure 5.

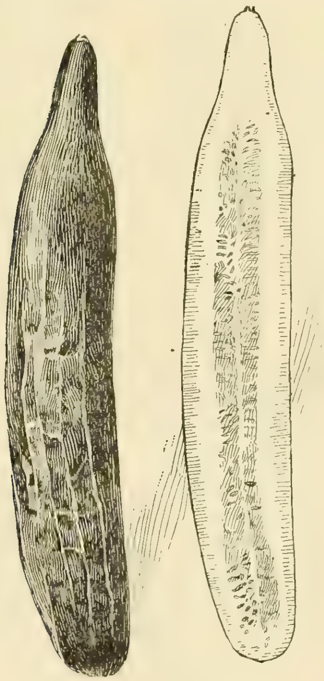


Fig. 5. *Telegraph, Seedless.*

Of ten blossoms of the variety known as "Sion House," covered as above, one developed fruit. Later many other blossoms were covered and some fruits were developed, but the percentage was about the same as before. The fruits, as with the "Telegraph," were straight and smooth and contained an abundance of partially developed ovules along the whole length of the fruit; but there were no perfect seeds. Other fruits of both varieties, left to natural conditions, were examined and as a rule were found to contain no perfect seeds. Indeed, this absence of seeds is a matter of common observation, and is urged as a point of excellence in favor of the English varieties. In one instance two or three apparently good seeds

were found, but no embryo was present, while most of the ovules were only one-eighth to one-fourth inch in length. There are few if any insects in a forcing house in midwinter which would be likely to carry pollen; and it is probable that fruits left to natural conditions received no pollen.

Other varieties exhibit characteristics peculiar to themselves, when pollen is withheld. "Blue Gown," for example, is almost invariably withered and shrunken at the apex or "blossom end," as shown in Figure 6. The same tendency is shown by the "Duke of Edinburg." No seeds are developed in these fruits, and at maturity they are often hollow at the lower end as shown in Figure 7.

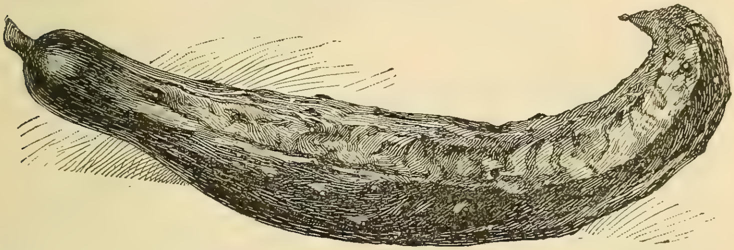


Fig. 6. *Blue Gown, not Pollinated.*

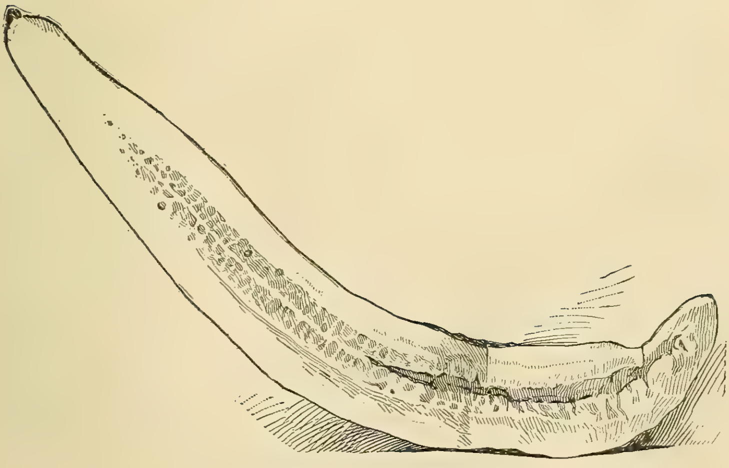


Fig. 7. *Duke of Edinburg, not Pollinated.*

In several instances I have observed the development of fruits on the "Duke of Edinburg," when the blossom never expanded. One of these is shown in Figure 8. The mature fruits were in every respect like those from which pollen was excluded by artificial means.

Fig. 8. *Duke of Edinburg.*

In our studies of the egg plant — *Solanum melongena* — we have at different times secured well developed fruits from blossoms which had been castrated and covered with paper bags to prevent access of foreign pollen. In no case have perfect seeds been found. The first instance noted was in the summer of 1890, and the fact was published the following spring.* During the past winter, 1891-92, experiments in this line have been repeated on plants growing in the house. Out of fifteen blossoms emasculated and covered, two apparently good fruits developed. One of these when about six weeks old began to decay, and was picked, and photographed. This fruit is shown in Figure 9.

As will be observed, the outer portions of the fruit grew much more rapidly than the inner,— the placentæ evidently requiring the stimulus of the growing ovules to induce development. The abortive ovules appear in the cavity as minute brown particles. A very few of them — ten in the whole fruit — were partially developed; indicating the possibility of a few grains of pollen having reached the stigma. The work was very carefully performed, however, and I am confident there is no error. The other fruit referred to is shown in the frontispiece. This fruit remained on the plant until fully mature. As will be seen, the fruit is normal in every respect except that it is *absolutely* seedless.

*Bailey and Munson, Experiences with Egg Plants. Bul. 26, Cornell Exp. Sta., 19.

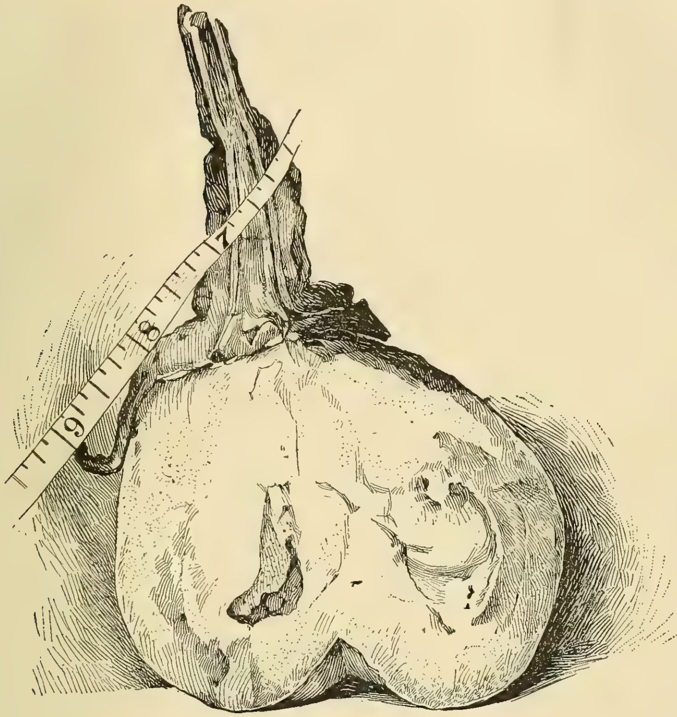


Fig. 9. *Egg Fruit, not Pollinated.*

It is interesting in this connection to note the fact that these fruits have usually, though not invariably, developed on cross-bred plants, rather than on fixed varieties,— a fact apparently in accord with the supposition before expressed, that excessive vigor of the plant is a prime requisite for the appearance of the phenomenon, for I have observed that as a rule, the cross-bred plants are apparently stronger and more productive than the others.

A further indication that excessive vigor of growth may affect the fruit, is in the abnormal development of the calyx of the egg plant in many instances, while the growth of the ovary is arrested. Usually the most prominent indication that impregnation has taken place, in the egg plant, is the rapid growth of the calyx. Many times, however, the calyx becomes much enlarged while for some reason the ovary fails to develop. I have frequently seen examples of this, in which the calyx was fully six inches long.

Another instance of the partial developnent of the ovary was observed in a Summer Crookneck squash to which pollen of another variety was applied by Professor Bailey, at the Cornell University. The fruit attained about eight inches in length, and remained in this condition during the season. No perfect seeds were developed.

From the evidence adduced the fact seems well established that in certain species, the ovary may develop and reach normal size without the corresponding impregnation of the ovules, and even in the entire absence of the male element. What the conditions are which induce this apparently abnormal condition, is not fully determined. It is evident, however, that vigorous growth of the parent plant is of first importance.

III. On the Amount of Pollen Required for Fertilization; and the Effects of Pollination on the Form and Size of the Fruit.

Kœlreuter, in 1761-66, found that with *Hibiscus venetianus* fifty to sixty pollen grains were sufficient to produce more than thirty fertile seeds in the ovary. In *Mirabilis jalapa*, and *M. longiflora*, which have a one ovuled ovary, two or three, and in some cases even one grain was sufficient for fertilization.† Now, according to Kœlruter, the Hibiscus produced 4863 pollen grains in a single flower,— or eighty-one times more than needed for actual fertilization. So also the Mirablis produced about 300 grains, or from 100 to 200 times too much. It appears therefore that there is no relation between the amount of pollen produced by a plant, and the amount required for fecundation.

Since the time of Kœlreuter, little has been done toward determining the actual number of grains required for the fertilization of any given species; but the fact has been plainly demonstrated that the amount of pollen applied may have great practical importance in determining the form and size of the fruit, as well as the quantity of fruit produced.

In crossing strawberries at the New York Agricultural Experiment Station, the fact was plainly brought out,‡ that the proportion of berries secured depends upon the abundance of the pollen

†Cited by Sachs, Hist. of Bot. 408.
‡5th An. Rep. N. Y. Exp. Sta. 179.

furnished by the variety used as a fertilizer,— a point which is of great moment if the same law holds under natural conditions. That there may be some doubt of this, however, is indicated by the fact that certain so-called pistillate varieties — notably the Crescent — at times mature "fruit" and apparently perfect seeds in the absence of any perfect flowering variety. One grower of my acquaintance uses no perfect flowering variety, and succeeds admirably. I have never seen these plants, but it is well known that the pistillate varieties frequently produce plants having partially developed stamens, and it is probable that by unconscious selection, plants of this character have been increased to a considerable extent. In any case, the amount of pollen is necessarily quite limited.

That the amount of pollen used may have an important bearing in determining the form and size of the fruit is certain. This fact, which is of special importance to the horticulturist, is shown by our work with tomatoes. In the winter of 1890-91, while crossing tomatoes, two stigmas in the same cluster of flowers were given different amounts of pollen. The first was given a very small amount — 10 to 20 grains — on one side of the stigma; the other

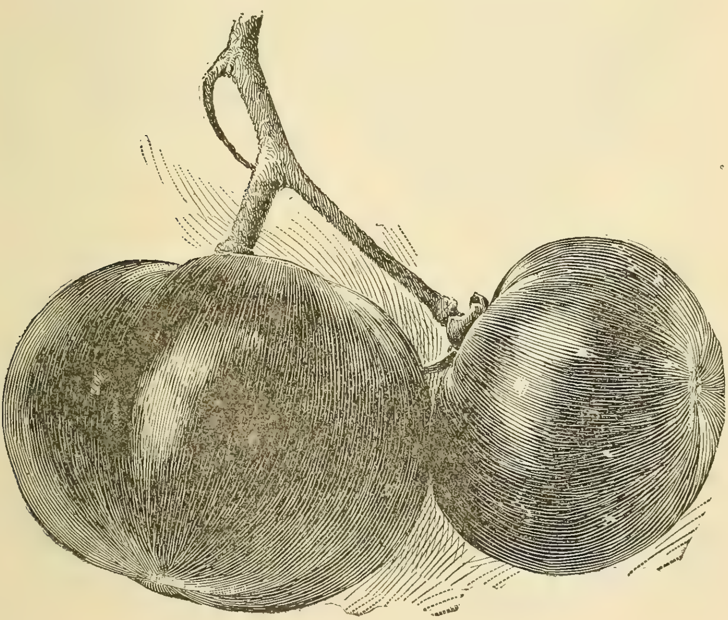


Fig. 10. *Different Amounts of Pollen.*

was given an excess of pollen, the stigma being well smeared. The effect on the form and size of the fruit was very marked. The fruit receiving the large amount of pollen was of normal size and nearly symmetrical in form, while the other was small and deformed. The larger fruit produced an abundance of seeds and all of the cells were well developed; the smaller developed seeds on one side only, while the other side was nearly solid.

Fig. 11. *Different Amounts of Pollen.*

During the past winter the experiments have been repeated many times and the results have been uniformly similar to those detailed. In the first case, — see Figures 10 and 11 — the flower nearest the base of the cluster received an excess of pollen, while the other received a very small quantity on one side of the stigma. In another instance — Figures 12 and 13 — the flower at the base received the small amount of pollen, while the other was given an excess. Similar results were obtained, indicating that the relative position of the flower has no influence in determining this point. As will be seen from Figure 13, the seeds in this instance — but ten in number — were all born in one cell, and the deformity of the fruit was correspondingly greater than in other cases. The difference in size of the fruits was even greater in some instances than in those already cited.

The exact number of pollen-grains necessary to insure partial development of the ovary, in case of tomato, I am unable to state at the present time. Certain it is, however, that the secondary action of the pollen in stimulating the growth of the fruit is of no small importance. No doubt the greater development of the one

side is largely due to fertilization of the ovules and the consequent growth of the placentæ; but that there is a further cause is indicated by the growth of the other side. Whether these results point to the possibility of securing seedless tomatoes by reducing the amount of pollen employed, is questionable. In no case have we secured fruit when all pollen was excluded, and in every case the size of the fruit was in direct proportion to the amount of pollen used.

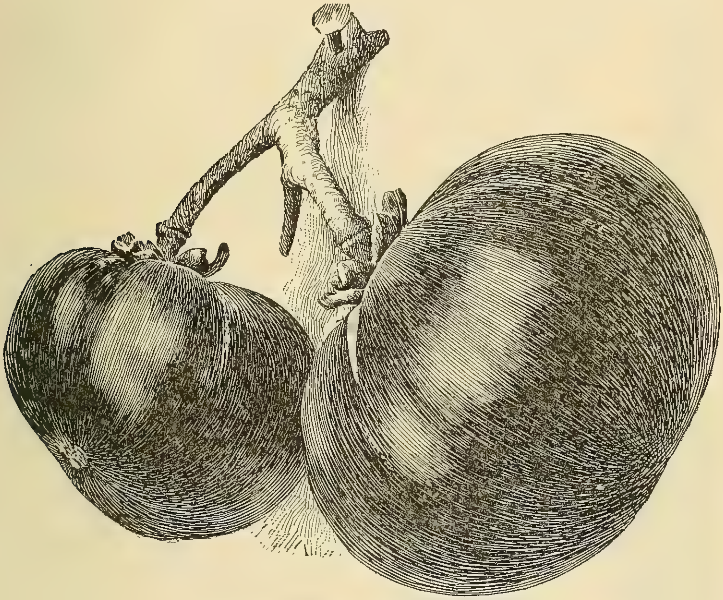


Fig. 12. *Different Amounts of Pollen.*

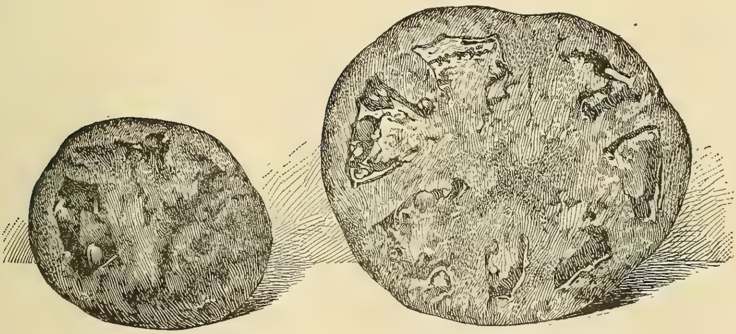


Fig. 13. *Different Amounts of Pollen.*

By careful selection we have secured tomatoes with relatively very few seeds; and Professor Bailey reports absolutely seedless fruits.* It is very doubtful, however, if these fruits can be regarded as any thing but variations. The habit of the plant has become so modified that the influence of the pollen in stimulating growth is stronger than its fecundating power. In none of the plants bearing relatively seedless fruits, was there an apparent lack of pollen.

Fig. 14.
Telegraph,
Artificially Pollinated.

A further instance of the modification of the form of fruit as a result of pollination, was observed with English cucumbers. As a rule, in cases of artificial pollination, if the fruit developed at all, the apex was much enlarged and perfect seeds were developed, — these seeds usually extending about one third of the length of the fruit. This result I have found to be almost invariable with some varieties, — notably the "Telegraph", of which an example is shown in Figure 14. This peculiarity of form is the usual result of pollination in other varieties also, but it is not invariably the case, and Professor Bailey regards the irregular form as "an expression of plant variation, rather than a result of particular treatment."† Certain individuals may be more susceptible to the influence of pollen than others, but as the variation is traceable directly to the action of pollen in the impregnation of the ovules, the subject may properly be considered in this connection. At the present time, however, we can only say that as a rule this particular variation is induced by the action of pollen. The reason is yet to be determined.

In other words, the reason for the failure of seeds to develop throughout the length of the ovary in the long English cucumbers, when pollen is applied to the stigma, is as yet uncertain. It appears probable, however, that the explanation lies in the extreme length of the ovary and the consequent inability of the pollen tubes to penetrate so far. There has been a variation in the ovary without a corresponding variation in the pollen. The amount of

*Rep. Cornell Univ. Exp. Sta. 1891, 55.
†Bailey, Bul. 31 Cornell Univ. Exp. Sta. 137.

pollen applied, appears to have little effect in regard to this point.

In general, while little accurate work has been done in the way of determining the exact amount of pollen necessary for fertilization, it appears that the question has bearings of much practical importance. In some instances the size of the fruit seems to be in direct proportion to the amount of pollen used, while the form is much improved by an abundant supply. In some cases, on the other hand, fruits will develop without the intervention of the male element, and the best results are obtained when pollen is withheld.

IV. On the General Influence of Foreign Pollen, and Other Miscellaneous Observations.

As already intimated, pollen appears in many cases to act directly on the ovary, stimulating growth of that organ independently of any effect on the ovules. This fact is most clearly seen in those species which do not readily cross.

In this connection, Focke remarks: "The pollen of the species acts quicker than foreign pollen and is alone effective if mixed with foreign pollen upon the stigma. * * * It is probable that if the pollen of the species is insufficient, foreign pollen may serve to develop the fruit, and thus serve a purpose."* Some instances strongly supporting this proposition have come under my observation.

One of the large English cucumbers, "Duke of Edinburg," was given pollen of the "Emerald Gem" muskmelon. The cross was made in February. The resulting fruit attained about one-half the normal size and then ceased growing. When the vines were torn from the house in June, this fruit was still green while other fruits, receiving pollen of the species two months later, were fully mature. The ovules in the fruit in question were wholly undeveloped.

Two other instances of a similar nature were observed. The first of these was the common Summer Crookneck squash crossed by the American Turban—Figure 15; while the second was the same variety crossed by Mammoth Tours pumpkin—Figure 16.†

*Die Pflanzen michlinge, 448.

†The two crosses last named were made by Professor L. H. Bailey at Cornell University. All other illustrations are from work performed by the writer.

In both of these cases the fruit developed, as indicated, about six inches in length, and remained in that condition several weeks. No seeds were developed, and late in the summer the fruits began to decay.

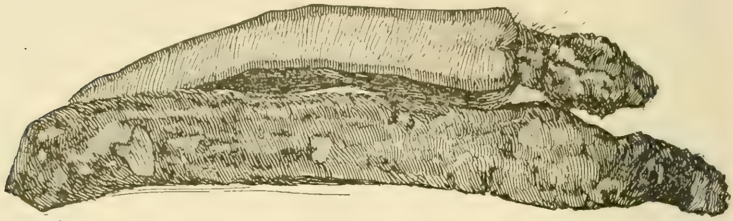


Fig. 15. *Summer Crookneck* × *American Turban.*

A most remarkable instance of secondary influence of foreign pollen is that recorded by Lowe.* Flowers of the yellow musk plant, *Mimulus luteus*, were crossed with *Mimulus cashmerianus* which has spotted flowers. When the pods from these flowers were nearly matured, other flowers upon the same branches were given pollen of *M. luteus.* More than one hundred seedlings were grown from these latter crosses and every one bore spotted flowers. In other words, the influence of the pollen of the foreign species was transferred along the branch and overcame the influence of pollen from the same species. (!)

This result is in direct opposition to Focke's principle of the prepotency of pollen of the species as compared with foreign pollen, and as yet, so far as I am aware, Lowe's statements have not been verified. I have undertaken to prove the truth or error of the statements, but have not as yet reached conclusions.

Superfœtation: Is it possible that the progeny of any plant may be in any way affected by the application of foreign pollen to the stigma after self-fertilization has already taken place? Is it possible to obtain distinct effects from two male parents when the pollen is applied at different times?

Comparatively little has been done towards solving these questions, and they are suggested as promising lines of investigation rather than as subjects for extended discussion at this time. Both Gray† and Focke‡ have denied the possibility of superfœtation, but other observers have cited instances in support of the

*E. J. Lowe, Rep. British Ass'n for Adv. of Sci. 1885, p. 1081.
†Am. Jour. Sci. and Arts XXV, 123.
‡Die Pflanzen mischlinge, 448.

theory and certain facts have come within my own observation which point to the possibility of several seeds in the same ovary being the product of different male parentage.

Grieve, in 1874,* individually pollinated several blossoms on some plants of *Pelargonium peltatum.* One of these plants was on the day following given pollen of *Pelargonium zonale.* The offspring of the first plant were all true *Pelargonium pelatum;* while of the offspring of the second, no two were alike, the leaves of some being large and of others small; some showed a well developed zone, while others were without any indications of this character.

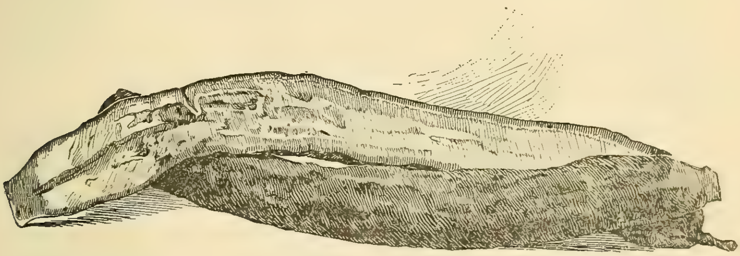


Fig. 16. *Summer Crookneck × Mammoth Tours Pumpkin.*

Charles Arnold, in crossing corn, used pollen from both a yellow and a white variety, on pistils of a dark purple sort. The resultant grains were yellow at the base and white at the top; while those of another ear on the same stalk, being individually pollinated, were of normal color.† This instance established in the mind of Mr. Arnold the fact of the possibility of superfœtation, and was used by Thomas Meehan‡ as the basis for an argument in support of the theory of the immediate influence of foreign pollen as well as of the theory of superfœtation. So far as I am aware, similar results have not since been obtained.

In applying small amounts of pollen to the stigmas of tomatoes, I have observed that the portion of the stigma receiving pollen soon turned brown and withered while the other side remained green and in an apparently receptive condition for some time. This fact was specially apparent in the fruit shown in Figure 12. As seeds develop only on the side receiving pollen, it seems probable that seeds on the other side of the ovary might well be fertilized by pollen of a different variety or species. This point is now receiving special attention.

*Gard. Chron Vol. II, (N. S.), 689.
†Gard. Month. XV, 104.
‡Proc. Phil. Acad. Sci. 1873, 16.

Conclusion.

From a study of the laws of heredity, conclusions of vast importance in the systematic amelioration of plants have been reached. At the present time, however, but little is known of the laws controlling the numerous secondary results attending the crossing of plants. From the evidence at hand it appears that the secondary results may be of fully as much importance as are directly inherited qualities.

There is little doubt that in a few important species there may be an immediate apparent effect of foreign pollen on the female organism of the current generation. It is equally certain, however, that the greater portion of food plants which have received special study do not exhibit any immediate apparent effects of foreign pollen; while other species are still in dispute.

That pollen has a direct stimulating effect on the ovary, independently of its action on the ovules, seems a well established fact. In many cases the size of the fruit is in direct proportion to the amount of pollen used; but it is also true that in many cases the fruit may develop to a considerable degree, or even to its normal size, in the entire absence of the male element. What the conditions are which insure this phenomenon is as yet uncertain. Exceedingly vigorous growth of the plant is certainly a first requisite, but there also seems to be an individual variation in this direction, with some species.

Variations in the amount of pollen available, may to a large extent determine the form and consequent value of the fruits of some species. It is certain that in some instances — as with tomatoes — the best practical results are obtained from an excessive supply of pollen; while on the other hand, some fruits — as is true of the English cucumber — may be of better form if pollen is withheld.

Whether superfœtation is possible, is a question of no small importance, but the evidence is as yet insufficient for conclusions to be drawn.

With all cultivated plants there is a tendency to revert to ancestral forms, and it is important that this fact be borne in mind in assigning definite causes to results obtained; otherwise, erroneous conclusions will often be reached.

General Summary.

1. The evidence at hand indicates that within certain limits there is an immediate influence of pollen on the mother plant; but that these limits are quite restricted.

2. The most important plants showing, unmistakably, immediate effects of foreign pollen are the pea, the kidney bean and the Indian corn. It is possible that the orange may be included in this list.

3. Sweet corn shows the effect of foreign pollen more frequently than do the other races of corn

4. Cucurbitaceous and solanaceous plants have not been fonnd to exhibit immediate effects of pollen.

5. Rosaceous plants are in dispute, but the weight of authority would indicate an absence of immediate effect.

6. The theory of the double action of pollen—stimulating as well as fertilizing—as suggested by Naudin and Focke, seems plausible; but in some species the ovary will develop in the entire absence of pollen.

7. The most important examples of agamic development of fruit, are seen in the Egg Plant—*Solanum melongena*—and the English forcing cucumber—*Cucumis sativus.*

8. In no instance, when pollen is witheld, are perfect seeds developed.

9. There appears to be no relation between the amount of pollen produced by a plant and the amount required for fecundation.

10. There appears to be no relation between the amount of pollen produced by a plant and the number of seeds produced by its fruits.

11. The amount of pollen applied may in many cases be of great practical importance in determining the form and size as well as the quantity of the fruit produced.

12. The amount of fruit produced by certain varieties of strawberries appears to vary, in some instances, with the amount of pollen supplied by the variety used as a fertilizer; but this occurrence is not universal.

13. The form and size of tomato fruits are directly dependent on the amount of pollen furnished,—a small amount invariably resulting in small and deformed fruit.

14. The English forcing cucumber is usually deformed by the production of seeds and the consequent enlargement of the apex, as a result of pollination; the amount of pollen used appears to be of no importance in determining the extent of the deformity.

15. Pollen appears in many cases to act directly on the ovary, stimulating growth of that organ independently of any effect on the ovules,—an effect most clearly seen in those species which do not readily cross.

16. Indications point to the possibility of distinct effects from two male parents when pollen is applied to the same stigma at different times.

REPORT OF THE HORTICULTURIST.

W. M. Munson.

In many respects the work of the horticultural department has been a continuation of that of last year. As indicated in my last report two distinct lines of work are in view; one being a study of principles and the laws affecting plant growth; the other a practical investigation of ways and means for immediate guidance in the culture of fruits and vegetables.

In studying the variations of plants, it is interesting and important to know what results may be expected from certain of the operations performed in the process of amelioration. During the past year special attention has been given to a study of the effects of pollination. The results of this study were published as Part II of the annual report of the experiment station. The field for investigation in this direction is very promising.

The work with insecticides and fungicides has been continued during the year and valuable lessons have been learned. Owing to the excessively wet season, results were not so marked as last year, but the beneficial effects of spraying are evident, and further effort in this line is warranted.

In our work with vegetables the tendency is to specialize rather than to grow a large number of varieties—particular attention being given to cabbages, tomatoes and egg plants. In the forcing house the pepino and the English cucumber, as well as the tomato, lettuce, radishes and other common crops demand attention. It is believed that with proper management the pepino may be made a profitable crop for winter forcing in those localities which can command a fancy market. A special report concerning the forcing of vegetables is now in preparation.

The fruit plantations have been largely extended and systematized, and with the provisions for increased assistance next year it is hoped the work may be prosecuted with renewed vigor.

THE VEGETABLE GARDEN.

While a greater variety of vegetables was grown during the past year than in 1891, we shall confine our report at this time to certain notes concerning cabbages, tomatoes and egg plants. Other important vegetables will receive attention at a later date.

I.—Notes of Cabbages.

As in the previous season, the study of cabbages was confined mainly to a few questions relative to methods of culture,—including the effects of handling; effects of trimming; a comparison of varieties, and the testing of the newer varieties.

No strictly new varieties were grown this year. "Nonesuch" and "Worldbeater," which were grown for the first time last year, were tried again and the good opinion expressed at that time regarding the first variety is confirmed. It is a very good second early sort. The average weight of this sort was about eight and one-half pounds. "Worldbeater" is a little later and in no way so satisfactory. The average weight of the heads is about the same as that of "Nonesuch."

Seeds from Long Island and from Fidalgo, Washington, did not give widely different results. The plants from both lots were very strong and vigorous from the start.

1. *Effects of Trimming:* It is frequently asserted that cabbage plants will thrive much better and give better results, if the leaf surface is reduced by about one-half at time of transplanting; since little growth will be made till the roots become established and the first leaves usually wither and fall away. To test this point, a number of plants of several varieties were trimmed at the time of setting in ths field, while others of the same lots were not disturbed. Rain fell soon after the plants were set and all of them grew remarkably well. The results are shown in the table.

TABLE I.—Effects of Trimming Cabbage Plants.

Variety.	No. of heads.	Total weight. lbs.	Heaviest head. lbs.	Lightest head. lbs.	Av'ge weight. lbs.	No. of heads cracked.	No. heads immature.	No. heads not cut.	Ratio.
Early Summer.									
Trimmed......	8	24.0	3.75	2.25	**3.00**	0	0	0	**1.00**
Not trimmed..	6	22.1	4.75	2.50	**3.70**	0	1	2	**1.23**
All Seasons.									
Trimmed......	15	116.5	12.87	3.87	**7.77**	1	0	1	**1.28**
Not trimmed..	11	66.5	11.50	2.19	**6.05**	0	3	0	**1.00**
World Beater.									
Trimmed......	15	124.5	11.75	4.56	**8.30**	1	0	0	**1.00**
Not trimmed..	17	143.0	13.37	5.37	**8.40**	0	0	0	**1.00**

As will be observed, there is little difference in the average weight of the heads from trimmed and untrimmed plants. With one variety the ratio is decidedly in favor of the trimming, while with another the indications are generally as positive in the opposite direction; while the third is neutral.

Conclusion: From work performed, it is impossible to make definite statements as to the value of trimming cabbage plants at time of setting.

2. *Influence of Transplanting:* Limited space in the forcing house prevented the continuation of this experiment on a scale as extensive as had been planned. A number of plants of two varieties, however, were given the same treatment as last year, *i. e.*: The plants handled in pots were removed from the seed-flats to three-inch pots, and later to four-inch pots. Those handled in boxes were placed two inches apart at the first transplanting and about four inches each way at the second. The boxes used were ordinary seed-flats, 16x20 inches, and about three inches deep. When placed in the field, all were set in rows three and one-half feet apart and two feet apart in the rows.

The results are shown in table II.

TABLE II.—POTS VS. BOXES.

VARIETY AND TREATMENT.	No. of heads.	Heaviest head. lbs.	Lightest head. lbs.	Av'ge weight. lbs.	No. of heads cracked.	No of heads immature.	No. of plants not cut.	Ratio.	Remarks.
JERSEY WAKEFIELD. (Brill.)									
Pots	22	5.50	2.00	**3.50**	7	1	0	**1.42**	Cut Aug. 4.
Boxes	56	5.94	.87	**2.47**	5	12	2	**1.00**	
STEIN'S FLAT DUTCH. (Thorburn.)									
Pots	17	12.87	4.31	**8.62**	5	0	0	**1.12**	Cut Aug. 24.
Boxes	24	13.00	2.94	**7.67**	4	0	0	**1.00**	

In each instance the average weight of the product is decidedly in favor of the plants handled in pots. This result confirms that obtained last season with the first variety, but contradicts that obtained with the second. The plants handled in pots were manifestly earlier and better than those from boxes, and the question now arises, whether the difference is sufficient to warrant the additional expense.

It is of interest to note that *Jersey Wakefield* seems specially susceptible to good treatment. In 1891 the ratio of the pot-grown plants to those grown in boxes was as 1.38 : 1.00, while the present season, as will be seen from the table, the ratio is as 1.42 : 1.00. Plants of this variety which were set deeply have almost invariably given better results than those set shallow, while other varieties have given various results in different years, though the same treatment was given.

Conclusion: The results are contradictory to those obtained in 1891, and indicate that pot-grown cabbage plants are earlier and better than those grown in boxes.

II.—Notes of Tomatoes.

The number of varieties grown the past season was not so large as in 1891, attention being given more particularly to methods of culture.

1. *Effects of Early Setting:* From our study of this subject last season, we found that: "On a warm, sandy soil, the earliness and productiveness of tomatoes were in direct ratio to the earliness of setting in the field," and that "a chill is not as fatal to success as is commonly supposed."* Accordingly, our principal setting was made on June 1st this year—nearly two weeks earlier than usual in this climate.

To verify the conclusions reached last year, when only one variety was used, three dozen plants of each of four varieties were set apart and given the same treatment in every way while in the house, all being transferred from the seed flats to 2-inch pots, then to 3-inch, and finally to 4-inch pots. The season being somewhat backward, the first lot was not put out until May 19. The other two lots were put out June 1st and June 15, respectively.

The night following the first setting there was a slight frost and the weather was cold and raw for a week following. As the plants were taken directly from the hot house, without "hardening off," the test was a severe one.

Table III shows very clearly the results obtained from this trial.

* Rep. Maine Exp. Sta. 1891, p. 91.

TABLE III.—EARLY AND LATE SETTING.

VARIETIES.	Date of setting.	No. of plants.	Av. No. fruits per plant.	Av. wt. of fruits per plant. lbs.	Av. wt. of individual fruits. oz.	Date of first ripe fruit.
EARLY RUBY.						
1st setting	May 19.	8	22.6	5.87	4.2	July 29.
2d "	June 1.	11	13.3	4.47	4.2	" 26.
3d "	" 15.	11	7.7	1.69	3.5	" 22.
ATLANTIC.						
1st setting	May 19.	12	10.2	2.14	3.4	Aug. 1.
2d "	June 1.	10	9.3	1.89	3.2	July 29.
3d "	" 15.	12	5.3	0.98	2.9	" 22.
NEW JERSEY.						
1st setting	May 19.	12	12.8	5.19	6.5	Aug. 9.
2d "	June 1.	12	12.0	5.00	6.7	" 8.
3d "	" 15.	12	4.4	1.33	4.8	" 6.
BEAUTY.						
1st setting	May 19.	12	18.4	7.10	6.2	Aug. 9.
2d "	June 1.	10	16.6	6.60	6.4	" 1.
3d "	" 15.	12	1.4	0.17	1.9	" 3.

From the table we learn first of all, that the first ripe fruits, in every instance save one, were obtained from the plants set latest. This fact, however, is not necessarily an indication of earliness, as the late-set plants were older than is usually desirable for setting and the first fruits were in some cases from blossoms formed while in the house. After these had ripened there was a long interval before others followed.

Without exception, the average number of fruits and the average weight of the product per plant, was in direct ratio with the earliness of setting,—a direct confirmation of results obtained last year. The average weight of individual fruits was not essentially different in the first two settings, but was decidedly less in the last lot.

2. *Effects of Bagging Fruit*: The editor of one of the leading agricultural papers* last year suggested covering the fruit with paper bags, as a means of inducing early ripening, claiming that in this way maturity might be hastened by several days. It is impracticable to cover individual fruits, but whole clusters on different plants of several varieties were covered and duplicate clusters of the same age were marked for comparison.

The following notes indicate the results:

* Rural New Yorker.

		Size at time of covering.	Date of ripening.
IGNOTUM.			
1	Covered July 14	Size of pea.	Aug. 29.
	Not covered............	" "	" 19.
2	Covered Aug. 6.........	" "	Sept. 21.
	Not covered............	" "	" 21.
PERFECTION.			
1	Covered July 12	" "	Aug. 19.
	Not covered............	" "	" 19
2	Covered July 14	" "	" 29.
	Not covered............	" "	" 19.
3	Covered July 14	½ inch.	" 29.
	Not covered............	"	" 18.
4	Covered Aug. 6.........	"	Sept. 27.
	Not covered............	"	" 21.
5	Covered Aug. 6.........	Size of pea.	" 27.
	Not covered............	" "	" 27.
PRELUDE.			
1	Covered July 14	½ inch.	Aug. 19.
	Not covered............	"	" 17.
2	Covered July 14	"	" 18.
	Not covered............	"	" 15.
3	Covered Aug. 13........	¾ inch.	Sept. 27.
	Not covered............	"	" 27.

In no instance did the fruit ripen earlier when covered, and in more than half of the cases considered, that not covered matured first.

Conclusion: Little or no benefit seems to be derived from the practice of bagging tomato fruits.

3. *Individual Variation:* In the culture of tomatoes, as of other garden crops, conclusions as to best methods are too often drawn from the results of a single season's work. There is little doubt that many of the conclusions thus reached are often misleading, for it is believed that the individual variation of the plants of any given variety is often such as to obscure any effects of different methods of treatment.

As bearing upon this question, duplicate lots of one dozen of each of several varieties were selected at the time of the first transplanting, and were given the same treatment at all times, being handled alike in the house and set in parallel rows in the field.

The comparative results are seen in table IV.

TABLE IV.—INDIVIDUAL VARIATION.

VARIETY.	Av. No. ripe fruits per plant.	Av. wt. of fruits per plant. lbs.	Av. wt. of individual fruits. oz.	Date of first ripe fruit.
Golden Queen	11	3.96	5.6	Aug. 8.
	20	6.00	4.9	" 4.
Ignotum	13	5.87	7.0	Aug. 1.
	12	5.23	7.2	" 1.
Perfection	24	8.90	5.8	Aug. 4.
	17	5.70	5.5	" 1.
Prelude	27	3.36	2.0	July 25.
	41	4.82	1.9	" 29.

In no case were the results obtained from the duplicate lots uniform. The variation in weight of individual fruits, and in the time of ripening, varied but slightly; but the number and weight of the product was very marked.

Conclusion: Positive conclusions should never be drawn from the results of a single season's work.

4. *Color:* As noted in last year's report, many attempts have been made to improve upon the color of the fruit of the tomato. The cross between Golden Queen and Ignotum, grown in the college gardens last year, gave no indication of any influence of the yellow parent; but the second generation was decidedly variable, about half of the plants bearing red fruits and the others yellow, with no indication of the desired blush form.

A selected strain of Golden Queen having a tendency to produce fruit with a blush cheek, is as yet only imperfectly fixed; but as grown in the house, this tendency is very nicely brought out and the fruits are very attractive.

A new variety to be introduced in 1893 by J. M. Thorburn & Co., of New York, as "Lemon Blush," is said to be a firmly fixed variety of the type sought. This variety originated with Mr. E. S. Carman, editor of the Rural New Yorker.

5. *Crossing:* Tomato growing in the high latitudes is often unsatisfactory for the reason that but a very small proportion of the fruit will mature before the plants are killed by frost. It is therefore important that some variety be secured which shall perhaps combine the size and quality of the better market sorts now extant with the earliness and prolificness of some of the smaller

sorts valuable only for preserves or catsup. With this end in view numerous crosses have been made, and the results obtained are interesting and promising.

During the winter of 1891-2 crosses were made between Ignotum, one of the most valuable market varieties, and the Peach, a very productive variety of excellent quality but small and soft.* Several plants resulting from this cross were grown in the field during the past summer, and were highly satisfactory. The fruit was in general not very different from the Ignotum, though averaging smaller; but the increase in productiveness was very marked. Whereas the average number of ripe fruits per plant on the pure Ignotum plants was but **18**, that on the crossed plants was **40**. The average weight of individual fruits, however, was but 3.3 oz. as compared with 7.5 oz. in case of the Ignotum.

In another instance two flowers on one cluster of the Lorillard were artificially pollinated—the one with Peach, the other with Lorillard pollen. The products of these crosses were given the same treatment throughout the season and were planted side by side in the field. The plants were essentially Lorillard in appearance, and the fruits as a rule were of this type, but some of the fruits showed distinctly the effects of the staminate parent.

The following figures represent very well the comparative yield of the two lots:

	Av. No. ripe fruits per plant.	Av. wt. of fruit per plant, lbs.	Av. wt. of individual fruits. oz.	First ripe fruit.
Lorillard × Peach	40	8.1	3.2	Aug. 12.
Lorillard × Lorillard	13	4.1	5.0	" 23.

The figures are significant. As will be observed, the individual fruits of the cross with Peach are somewhat smaller than those of the pure Lorillard—being about intermediate between the usual sizes of the two parents—but the number of fruits is trebled, while the average weight per plant is doubled. The date of ripening also is hastened by more than a week. The fruit showed little tendency toward the peculiar roughness of the male parent. All things considered this cross is very promising.

* For description of these varieties see Rep. Maine Exp. Sta. 1891, pp. 91 and 92.

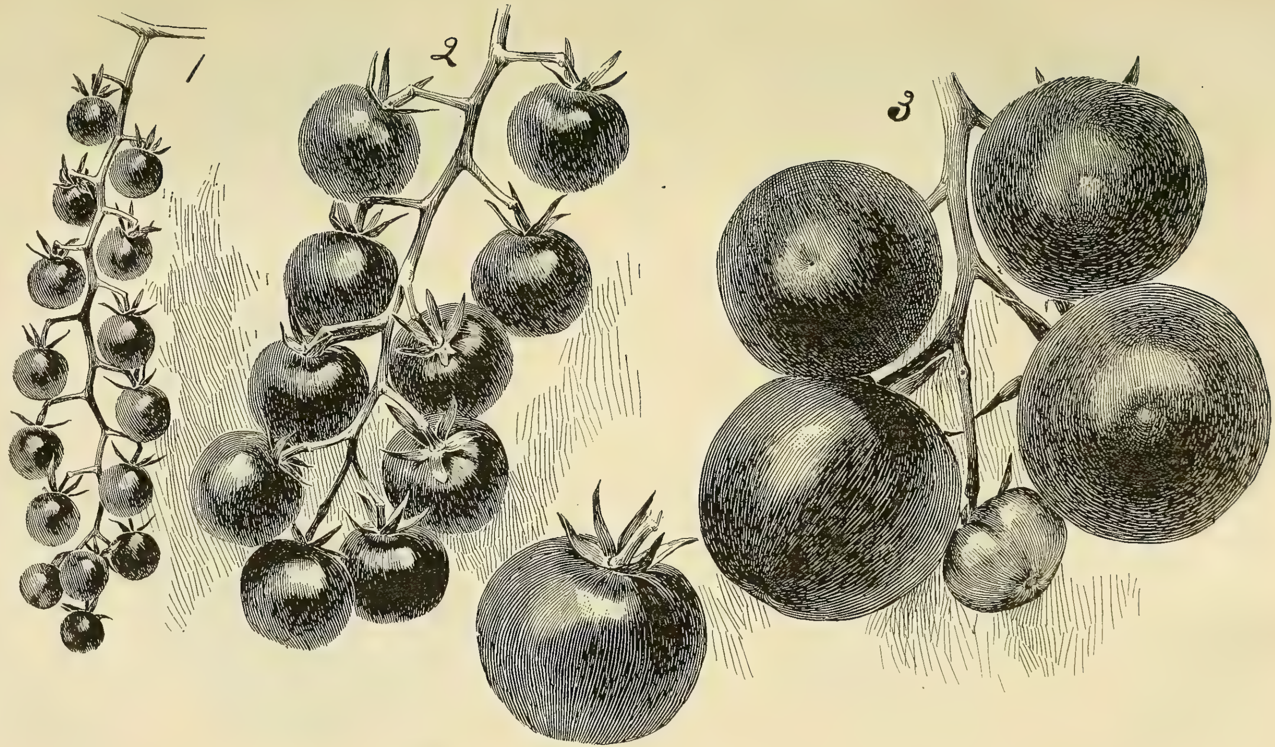
1. Currant. 2. Hybrid. 3. Lorillard.

Fig. 1 Lorillard × Currant.

Besides the crosses already named, a true hybrid was secured between the Lorillard and the Currant. The Lorillard is a well-known variety of medium size and of only moderate productiveness, belonging to the common type of *Lycopersicum esculentum*, while the Currant belongs to a distinct species—*Lycopersicum pimpinellifolium*. The Currant tomato is of weak spreading habit, with small, thin foliage and very delicate flowers, arranged in two ranks on a long raceme. These flowers, from 10 to 20 in number, are highly self-fertile and the fruit very closely resembles long clusters of cherry currants. The difference in the appearance of the leaves of the two varieties is very well shown in Fig. 1, Nos. 1 and 3. The difference in the flowers is equally marked, those of the Lorillard being somewhat conical, with the calyx lobes much longer than the petals; while those of the Currant are slender and the calyx lobes are so small the petals and stigma often protrude.

The resulting hybrids were intermediate between the parents in nearly every particular. The character of the foliage is well shown in Fig. 1, No. 2. The fruit, which from a practical point of view is most important, presented a very attractive appearance. Much of the productiveness of the Currant is shown, while the influence of the size of the Lorillard is also exhibited. The size and character of the fruit may be seen from Fig. 2. No. 1 represents the male parent — Currant; No. 3, the female — Lorillard; while No. 2 is the hybrid, all being about one-half size. The detached fruit shows the natural size of the hybrid.

Our purpose now is, by futher combining the hybrid with the Lorillard, to increase the size of the fruit, at the same time retaining if possible the prolific tendencies of the plant. To this end crosses have been made of the hybrid on the Lorillard and of the Lorillard on the hybrid and the results are awaited with interest.



1. Currant. 2. Hybrid. 3. Lorillard.

Fig. 2. Lorillard × Currant.

6. *Secondary Effects of Pollen:* This matter was discussed in Part II of the annual report of this experiment station for the present year; but as that report was of a technical nature and not printed for general distribution, some of the notes there given referring to the tomato may be repeated in this connection. From our studies of the subject of plant breeding, we have found that the amount of pollen falling on the stigma of the tomato flower may have an important bearing in determining the form and size of the resulting fruit. In the winter of 1890-1, while crossing tomatoes, two stigmas in the same cluster of flowers were given different amounts of pollen. The first was given a very small amount, while the other was given an excess. The resulting fruit from the first flower was small and deformed, while the other was of normal size and nearly symmetrical in form. The larger fruit produced an abundance of seeds and all of the cells were well developed; the smaller developed seeds on one side only, while the other side was nearly solid. This difference is very well shown in figures 3 and 4.

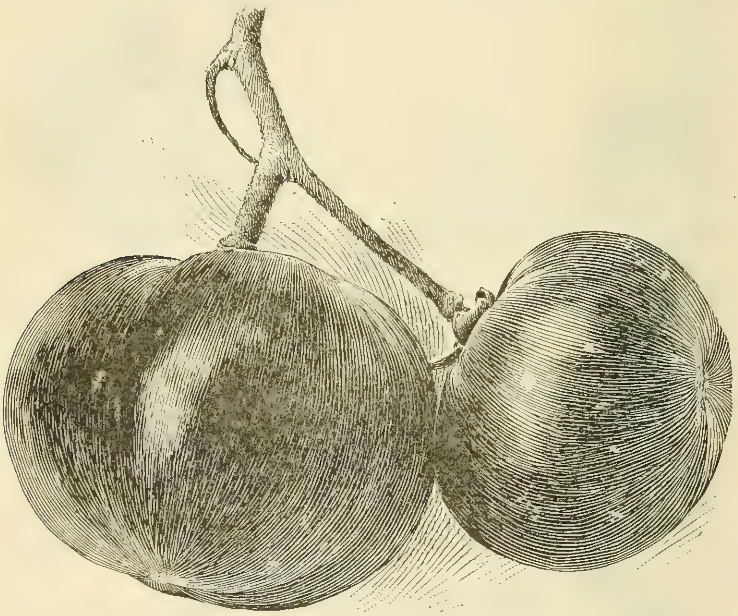


Fig. 3. *Different Amounts of Pollen.*

It is certain that the secondary action of pollen in stimulating the growth of the fruit is very important, and the question naturally arises as to what influence would be manifested on the

offspring. Seeds from several of the fruits under study were sown in the house, but owing to an accident the test as to per cent. and rapidity of germination was abandoned. Several plants of each lot were grown, however, and were treated precisely alike during the season, with the results shown in the accompanying table.

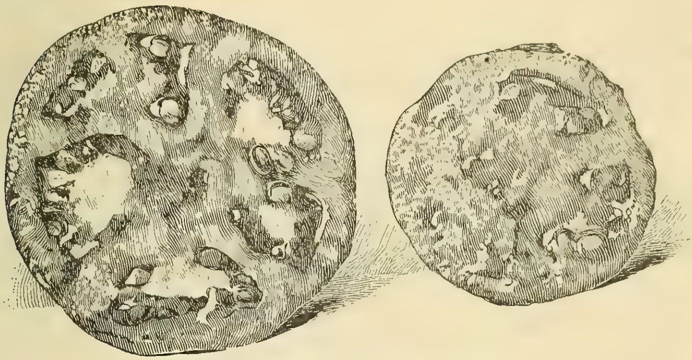


Fig. 4. *Different Amounts of Pollen.*

Each cluster of fruits is designated by a letter and the individual fruits by the word "maximum" or "minimum" according as an excess or a very small amount of pollen was employed.

TABLE V.—Secondary Influence of Pollen.

		No. of plants.	Av. No. of fruits per plant.	Av. wt. of fruit per plant. lbs.	Av. wt. of individual fruits. oz.	Date of first ripe fruit.	No. fruits ripe before Sept. 15.
A	Max	3	69	17.7	4.11	Aug. 9	23
	Min	3	68	17.3	4.09	" 8	25
B	Max	4	50	10.7	3.43	Sept. 1	21
	Min	2	27	4.6	2.74	" 5	3
C	Max	6	58	13.3	3.70	Aug. 6	38
	Min	3	70	15.3	3.49	" 12	15
E	Max	6	82	21.1	4.62	Aug. 17	20
	Min	4	74	20.0	4.32	" 18	22

As a rule, the offspring from the fruits receiving an excess of pollen were slightly the more productive and without exception the average weight of the individual fruits from these plants was greater. In general, however, the difference was but slight.

Further study on this point may throw some light on the question of the importance of the individual characteristics of a fruit

in the selection of seed. We have already observed* that the character of the individual fruit is of less importance than that of the parent plant as a whole, but it also seems that the small size of the fruit, which we now believe specifically due to imperfect pollination, may be co-incident with lack of vigor, and that this lack of vigor will be apparent in the offspring to a greater or less extent.

8. *Varieties:* Among the varieties grown the past season were most of the older standard sorts and some of the more recent introductions. The accompanying table will give a comprehensive view of the comparative merits of these varieties as regards size, productiveness and earliness.

TABLE VII.—COMPARISON OF VARIETIES.

VARIETIES.	No. of plants.	No. of fruits.	Av. No. fruits per plant.	Wt. of fruit per plant. lbs.	Av. wt. of individual fruits. oz.	Date of first ripe fruit.	No. of fruits ripened before Sept. 15.
Americus Hybrid	11	131	11.9	4.74	6.4	Aug. 1.	40
Atlantic	12	194	16.2	4.20	4.2	July 29.	70
Chemin Market	12	169	14.1	3.96	4.5	Aug. 1.	59
Cleveland	11	158	14.4	6.00	6.7	" 11.	39
Early Richmond	12	201	16.7	5.65	5.0	" 3.	89
Early Ruby	12	200	16.7	5.13	4.9	July 26.	81
Essex Hybrid	11	117	10.6	3.92	5.9	Aug. 2.	35
Faultless	12	310	25.8	7.21	4.5	" 1.	93
Favorite	12	135	11.2	4.46	6.4	" 8.	39
Golden Queen	11	124	11.3	3.96	5.6	" 8.	38
Ignotum	12	161	13.4	5.87	7.0	" 1.	61
Ithaca	10	202	20.2	5.34	4.2	July 29.	82
Long Keeper	12	241	20.1	6.93	5.5	Aug. 11.	34
Lorillard	12	249	20.7	7.57	5.8	" 3.	69
Livingston's Beauty	12	164	13.7	4.95	5.8	" 9.	45
Mikado	11	170	15.5	8.00	8.3	July 25.	42
Mitchell	11	203	18.5	6.11	5.3	Aug. 3.	50
New Jersey	12	168	14.0	6.48	7.4	" 12.	31
Optimus	12	299	24.9	7.89	5.1	" 1.	98
Paragon	12	141	11.7	4.74	6.5	" 9.	38
Perfection	10	140	14.0	5.00	5.7	" 2.	41
Ponderosa	11	67	6.1	4.19	11.0	" 11.	14
Potomac	12	207	17.2	2.55	7.0	" 4.	47
Potato Leaf	11	222	20.2	7.40	5.9	" 2.	48
Prelude	12	327	27.2	3.36	2.0	July 25.	129
Red Cross	12	209	17.4	6.00	5.5	Aug. 2.	46
Stone	11	111	10.1	3.90	6.2	" 8.	25
Table Queen	12	173	14.4	6.40	7.1	" 2.	51
The Hovey	9	153	17.0	6.20	5.8	" 5.	45
Volunteer	12	226	18.8	6.73	5.7	" 5.	73
Yellow Victor	12	328	27.3	7.27	4.3	" 1.	136

The most productive varieties, in point of number, were Yellow Victor and Prelude, with an average of 27 ripe fruits per plant, before frost. Following these were Faultless with 26, and

* Bulletin 21, Cornell University Experiment Station, page 75.

Optimus with 25; while Lorillard, Potato Leaf, Ithaca and Long Keeper ripened about 20 fruits each. Some of the larger fruited sorts produced a greater weight of fruit, but there were not as many individuals, and as a rule, medium-sized varieties are more to be desired. Prelude is very small and Optimus, with its average of 25 fruits, is far superior to it.

The date of the first ripe fruit is not an exact criterion of earliness of the crop, but in average seasons frost may be expected any time after Sept. 15, and the number of fruits ripe at that date is a safe guide, other things being equal, in selecting an early variety. The five varieties ripening the greatest number of fruits at this time were respectively, Yellow Victor, Prelude, Optimus, Faultless and Early Richmond. As will be seen, Optimus again stands third in the list and it is by far the best of the five varieties named. Of the other most productive and valuable sorts, Ithaca matured the most fruit before the date above mentioned, while Early Ruby and Volunteer came next in order.

The following field notes concerning the most important varieties were made:

Atlantic. (*Atlantic Prize*, Thorburn).—Of medium size, red, irregular, better than in 1891, but not of sufficient merit to retain.

Beauty. (*Livingston's Beauty*, Livingston).—Still a favorite pink tomato. Smooth and handsome, but not quite as productive as in former years.

Chemin. (Cornell University). Larger than in 1891 and very productive, but too late for field culture. It is one of the most profitable varieties we have under glass.

Cleveland. (*President Cleveland*, Farquhar.)—Large, smooth, red, resembling Perfection, with which it compares very favorably this year. Better than in 1891.

Faultless. (Farquhar).—Although one of the most productive varieties grown, the fruit is too irregular to be of value.

Ignotum. (Cornell University).—One of the best, but not quite so productive this year as some others.

Ithaca. (College Garden, 1891).—One of the most promising purple varieties in our collection. Is worthy the attention of seedsmen.

Long Keeper, (Thorburn).—The good impression formed last year is confirmed. It is one of the best purple tomatoes, though not quite as early as Beauty.

Mitchell. (Gregory).—Large, smooth, red ; much flattened and stem set in deep basin. Ripens evenly and is productive. Much better than last season.

Optimus. (Thorburn).—Of medium size, smooth, red ; productive. All things considered the most satisfactory variety in our collection this year.

Perfection. (Livingston).—Sustains its reputation as one of the best red tomatoes.

Ponderosa. (Henderson).—Very large, irregular, light purple, resembling Mikado except in foliage. Quality mild and good, but not productive. Rarely more than two or three fruits in a cluster.

Potomac. (Harris).—Large, pink, considerably flattened but not irregular. Not superior to other sorts of this class.

Potato Leaf. (Livingston).—Of medium size, smooth, pink. Plant vigorous and productive. Good.

Red Cross. (Farquhar).—Of medium size, smooth, red. Ripens evenly with little tendency to crack ; but like the preceding, rather late.

Richmond. (*Early Richmond*, Landreth).—Large, red, very irregular. Not valuable.

Ruby. (Henderson).—Of medium size, red, angular. Early, but otherwise not valuable.

Stone. (Livingston).—Large, smooth, scarlet, solid. Productive, but late.

Volunteer. (Cornell University).—Of medium size, smooth, red. Plant vigorous and productive. Good.

Yellow Victor. (Gregory).—Of medium size, much flattened, inclined to be irregular. Resembles the old Large Yellow, though somewhat smoother. Of no special value.

The varieties which gave best satisfaction during the past season were : Optimus, Lorillard, Long Keeper, Ignotum, Ithaca, Perfection, Potato Leaf. Stone and Chemin Market are too late for profit. Ponderosa though exceedingly large and of good quality is too irregular and too uncertain to rank high.

Ithaca, which has never been introduced to the trade is a valuable sort worthy of dissemination.

Early Ruby and Atlantic Prize, while early, are not enough superior to other varieties in this respect to overcome the objections as to irregular form.

SUMMARY.

1. The average productiveness of tomato plants, both as regards number of fruits and weight of product, appears to be in direct proportion with the earliness of setting in the field.

2. Little or no benefit seems to be derived from the practice of bagging fruit.

3. Individual variation is such as to render conclusions drawn from a single season's work very unreliable.

4. Crossing between small fruited plants of very prolific habit and the larger fruited sorts, is a promising method of securing valuable varieties, which shall be sufficiently early for the best results.

5. Plants grown from seeds of small fruits—those receiving little pollen—were slightly inferior to those grown from large fruits from the same parent plant.

6. The best variety grown during the season, all things considered, was the Optimus.

7. Among the best varieties for general use are: *Red*, Optimus, Perfection, Ignotum, Lorillard; *Pink*, Potato Leaf, Beauty, Long Keeper; *Yellow*, Golden Queen.

8. Of the newer varieties, Cleveland, Long Keeper, Mitchell and Stone are desirable; while Richmond and Yellow Victor do not appear to be of special value.

III. Notes of Egg Plants.

The egg plant is one of the important vegetables which has as yet received little attention in this State, and the poor withered specimens sent in from other states give consumers little idea of the delicious character of this plant when fresh and well served. No doubt also, the fact that it is not common, and that cooks are not accustomed to serving it, may account to a large extent for its neglect.

The egg plant is a native of tropical America, and reaches perfection only in a warm climate and near the coast. By careful treatment, however, and by a process of acclimatization, it may be successfully grown far inland and much farther north than commonly attempted, as the successful plantings in the college gardens for the past two years abundantly prove.

Fig. 3. *Black Pekin.*

The following notes embrace the more important results of our experiences with this plant during the past four years:

1. *Culture:* As a long season is required for the egg plant to mature, it is highly important that the plants be started early. It is our practice to sow the seeds in "flats"—shallow boxes about three inches deep—in a warm forcing house about the middle of March or the first of April. After about a month, or when the first true leaves are nicely started, the young plants are pricked off into other boxes, two inches apart each way, or, better, into 2-inch pots. About three weeks later, when the pots are well

filled with roots, or when the plants begin to crowd, the latter should be shifted to 4-inch pots. We have almost invariably had better success when the plants were handled in pots than when they were transplanted into other flats, the check caused by frequent disturbance of the roots appearing to be detrimental to most sorts. An exception is noted, however, in case of the Early Dwarf Purple which seems able to withstand very harsh treatment.

It is important that the plants be kept growing vigorously from the start, as they seldom fully recover from a check, and in order that fruit mature the plants must be strong and vigorous when planted in the field.

The plants may be set in the field, in this latitude, about June 10th to 15th. We usually set them in rows about three feet apart that they may be cultivated by horse power. The soil should be a rich sandy loam containing an abundance of organic matter. Heavy dressings of stable manure are advisable. Frequent and thorough cultivation are absolutely essential to success.

Perhaps the worst insect enemy of the egg plant is the potato beetle. The tender foliage of the young plants is specially subject to attack, and as the growth is so slow, severe injury nearly always proves fatal. Paris Green, one pound to one hundred gallons of water (about one-half teaspoonful to a large pailful of water), applied about once a week, will be found useful.

2. *Methods of Serving:* No doubt the fact that cooks are not familiar with methods of serving the fruit of the egg plant accounts to a large extent for the failure to use it more. The following recipes for cooking the fruits are given in Bulletin 26 of the Cornell University Experiment Station, and have been found satisfactory:

"1. *Fried.* Cut in slices cross-wise not over a half-inch thick and parboil about fifteen minutes; then remove and fry in a hot spider in butter and lard.

"2. *Fried.* Cut into slices ¼ to ½-inch thick and lay in strong brine for two hours; then wash *very* thoroughly; sprinkle with brown sugar, pepper and salt and fry slowly to a dark brown.

"3. *Baked.* Cut in two length-wise, remove the seeds and pulp and fill with dressing made of half teacupful bread crumbs, one teaspoonful butter, and salt and pepper to taste; lay the halves side to side in dripping pan, add a little water and bake nearly an hour.

"4. *Fritters.* Pare, cut in slices cross-wise and soak in salt water for eight or ten hours; dry on a towel, dip in beaten egg and roll in bread crumbs, then fry slowly in hot butter until the pieces become rich brown; serve hot."

3. *Varieties:* For several seasons we have grown such varieties as we could obtain from all sources. The number of varieties is comparatively limited, but there are several distinct types of varying importance. These types vary in regard to color, size, form, habit of plant and season of maturity. Some from their earliness and productivenss but small size, are valuable only for home use. Others by virtue of their large size and attractive appearance are popular in the markets, but as a rule they are not sufficiently early and productive for the short seasons of this latitude.

The following varieties have been grown in the college garden during the past two seasons and the illustrations are from photographs of plants grown here.*

Black Pekin. (Thorburn).—Plant large and vigorous; stems petioles and veins always deep purple; leaves large, more or less distinctly lobed, purple with metalic lustre above. Fruit large, 5 to 7 inches in diameter,—often larger—spherical or oblate, very dark purple. Entirely distinct from every other variety, rather late but it fruited well the past season. A popular market variety.—See fig. 3.

Fig. 4. *New York Improved.*

New York Improved. (Thorburn, Gregory).—Plants large and vigorous, erect; stems, petioles and veins dark green or purplish on upper surface; leaves very large, lobed, downy, with large

* Cuts for figures 6, 8, 9 and 10 were loaned us by the Cornell University Experiment Station.

TYPES OF EGG PLANTS See page 78.

1. New York Improved. 2. Black Pekin. 3. Long Purple. 4. Dwarf Purple. 5. Round White. 6. Long White. 7. Cross. (B 7 (*a*) p. 89.)

spines on the mid-rib. Fruit large to very large, oblong, dark purple. The most common market variety, but too late for this latitude. See fig. 4.

Round Purple. (Thorburn, Landreth).—Plant of medium size but vigorous and fairly productive. Fruit small to medium in size, spherical or oblong, pale violet. Its color renders it undesirable.

Fig. 5. *Long Purple.*

Early Long Purple. (Thorburn, Gregory).—Plant of medium size, dark green or slightly purplish; leaves medium in size, slightly lobed. Fruit long, club shaped, dark purple, of excellent quality, one of the very best for general culture. See fig. 5.

Early Dwarf Purple. (Gregory).—Plant, low, weak, spreading, spineless; stems and petioles dark purple, slightly downy, leaves small, dark green with purplish tinge. Fruit small—three

to six inches long—pyriform, dark purple. The earliest and most productive variety grown; hence perhaps the most valuable for home use. It is too small, however for a market sort. We have found this sort better able to overcome the effects of neglect than any other variety grown, and plants started in a hot bed as late as the first of May have given excellent results. Fig. 6.

Fig. 6. *Early Dwarf Purple.*

Long White. (Thorburn).—Plant of medium size, erect, light green, downy; leaves of medium size with undulate margins. Fruit long, frequently curved, abruptly rounded at the apex; pure white, becoming yellowish at maturity. A good variety—See fig. 7.

Round White. (Thorburn).—Plant small, upright, bright green; stems, and petioles smooth and shining under a slight covering of down. Fruit small—rarely four inches long—egg shaped, white and like the preceding yellowish, at maturity, very prolific and early, but hard and tough rendering it scarcely edible. Valuable only as an ornament. See fig. 8.

Striped on Guadeloup. (Thorburn).—Plant vigorous, erect, resembling that of Long White. Fruit oblong,—three to five inches long—white with purple longitudinal stripes. Exceedingly prolific, but valuable only for ornament.

4. *Experiences in Crossing*: Our studies of this subject began in 1889, when several crosses were made with the specific purpose of producing new types combining the most valuable features of existing varieties. Some of the earlier results were published in a bulletin from the Connell University, in 1891;* but it will be necessary to repeat some of the statements there made in the present connection.

In 1889 three distinct series of crosses were made. The first of them, which we called *Series A*, was the Round White crossed by pollen from Black Pekin (see figures 8 and 3). These varieties represent two widely different types, and it was hoped we could combine the earliness and productiveness of the former with the beauty of form and color and the excellent quality of the latter.

Fig. 7. *Long White.*

In the second cross, which we called *Series B*, Giant Round Purple was crossed with pollen from White Chinese. The first of these—figure 9, differs little from New York Purple except in size of fruit which is very large. White Chinese differs little in habit from Long White described on page 80, but the fruits are slightly larger and usually curved, (see figure 10). It is a very handsome variety. These two sorts have not been grown in Maine.

In the third cross, *Series C.*, Long White was crossed with Black Pekin. Long White in this case differed from the sort described under that name on page 80, in that the fruit was shorter, being somewhat ovoid in form, while the color was greenish white.

The seeds resulting from all of the above crosses were sown in 1890, and the plants were given conditions as nearly uniform as

* Bailey & Munson, Bul. 26, Cornell Univ. Exp. Sta., March, 1891.

possible. The plants proved quite variable, and crosses and selections were made in the hope of fixing the more valuable types. Seeds of some of the best of these were brought by the writer to Maine, and were planted in 1891.

Following, is a somewhat general account of the results obtained with each series:

Fig. 8. *Round White.*

Series A.

Round White X Black Pekin.—One fruit, the result of the first cross, gave in 1890 a series of plants intermediate in general character, between the parents. The young shoots were much like the pistillate parent,—Round White—but as they became older, the upper surface of the stems, the petioles and the veins of the leaves became of the purplish color of the male parent. In form and size, most of the fruits varied in the direction of the pistillate parent. Some were larger, however, and frequently the same plant would bear mature fruits two inches and others five inches in diameter. In color, the fruits were purple while young—usually dark purple with lighter apex. Occasionally this color was retained till time of edible maturity, but as a rule,

the dark purple became of a dull greenish cast, while the apex became metallic gray with streaks of grayish purple extending towards the base.

From this first generation, several crosses and selections were made for further study. These were as follows:

A 1. Given pollen from another flower of same plant.
A 2. Given pollen from Round White (female parent).
A 3. Given pollen from Black Pekin (male parent).
A 4. Same as A. 3.
A 5. Same as A. 1.
A 6. Same as A. 1.
A 7. Same as A 2.
A 8. Selection, parentage uncertain.

Of the above selections the fruit was uniformly of the color before described, but varied considerably in size. The general characteristics of the plants were as follows:

A 1. Of the general habit of Round White,—the pistillate parent—but the upper surface of stems, petioles and veins was purple, showing influence of the male parent. Of the four fruits borne, two were the size of a hen's egg, and two much larger—6 inches long.

A 2. Similar to the first, but the purplish tinge less marked.

A 3. Plant strong and vigorous, with upper surface of stems and leaves dark purple.

A 4. Plant vigorous, leaves much larger than with the first three, many of them being considerably lobed, and all of the pronounced purplish cast of Black Pekin. The fruits, however, were shaped like Round White.

A 5. Plant of medium size, bright green. Two fruits of medium size—about six inches long—mostly of two shades of purple, with upper surface dark green. Very mature fruit has yellowish cast of Round White.

A 6. Very similar to A 5.

A 7. Plant of the general type of the series. Fruits of three distinct forms, one like Round White, a second four inches in diameter and like Black Pekin, the third spherical and very small.

As an example of variability induced by crossing, this series is one of great interest. There were no immediate effects of pollen,

but we find in the first generation marked indications of the influence of both parents—the habit of the plant and the size of the fruit resembling the female, while the color of the male is apparent.

None of the products of this series promised to be of any commercial value, however, and they were not considered by the writer after leaving Cornell. All of the seeds from each of the individuals treated as indicated on page 84 were sown by Professor Bailey, in 1891, and his comments on the behavior of the resulting plants, as published in a recent bulletin,* are here given :

Fig. 9. *Giant Purple.*

"It is interesting to note the influence of Black Pekin in A. 3 and A. 4, into which this variety has twice entered as a staminate parent. All the plants 203, in number, were purple in foliage and like Black Pekin in habit; and most of the fruits were solid purple, although a few striped fruits still showed the influence of the Round White two generations back. The ones into which the Round White entered twice—A. 2 and A. 7—do not show so strongly the marks of the double infusion of blood. In A. 2,

* Bulletin 49, Cornell University Experiment Station, Dec. 1892.

there are a few more plants with green, than with purple herbage, and the green ones were more productive than the others ; these are marks of the Round White, and it may also be said that even the purple plants were of a light cast, and that nearly all showed the influence of the dwarf habit of Round White. A. 7 the other Round White Cross, produced a lot of small plants, but they were unproductive and much over half of them had purple herbage."

A 1, A 5 and A 6, pollinated from another flower of the same plant were exceedingly variable. "In fact A 1 was probably the most hopelessly mixed of any in the entire list. The fruits ranged from pure white to green with white stripes, purple striped, light solid purple, and very dark purple ; and the mature fruits varied from the size of an egg to that of Black Pekin. About equal numbers of the 175 plants were green and purple. A 5 was nearly as badly mixed, and some plants appeared which had the peculiar spreading habit of Early Dwarf Purple, a variety which had never entered any of the crosses. A 6 showed wide variations also. A 8, which was simply a selection and had not been artificially pollinated, was about as variable as the rest."

It will thus be seen by comparing the characteristics of the plants of the two generations that crossing with either parent served merely to intensify tendencies already existing, and that the use of pollen from another flower of the same plant was apparently ineffectual in serving to "fix" any type.

Series B.

Giant Round Purple X *White Chinese.*—This cross resulted in some of the most promising types I have ever grown. The plants, as in series A, were as a rule intermediate in habit and character between the parents. The sturdy, vigorous habit of Giant Purple, the female parent, was exhibited, but the leaves were smaller and less distinctly lobed than in that variety.

In form the fruits, as a rule, resembled the male parent, White Chinese, but they were of greater diameter. The color at edible maturity was rich dark purple with lighter apex. When left for seeds to ripen, the dark purple body of the fruit became of a dull greenish hue, while the lighter apex became gray, then yellowish like the male parent.

As in the first series, a number of individuals were again crossed with the original parents and some of the more promising types were selected without artificial pollination. All of these crosses and selections were grown by Professor Bailey at Cornell University,* and some of those appearing most valuable were brought by the writer to Maine.

Fig. 10. *White Chinese.*

The parentage of those grown at this station was as follows:

B 1. Crossed by Giant Purple (female parent).

B 2. Pollinated by another flower from same plant.

B 3. Crossed by Giant Purple.

B 5. Crossed by Giant Purple, as in B 1 and B 3.

B 7. Selection, not artificially pollinated.

In every instance these parent fruits were of the general form and color above described. The offspring, however, were exceedingly variable. The plants were of the intermediate type, charac-

* See Bulletin 49 Cornell Univ. Exp. Sta., Dec., 1892.

terizing those of the first generation, but in the fruits wide differences were noted. B 1 into which Giant Purple has twice entered —first as pistillate, then as staminate parent—still showed the effect of White Chinese in two out of the eight plants grown. As a rule the fruits were dark purple and of greater diameter than the immediate parent, but one fruit while of the form of Giant Purple had the light apex and streaks of the immediate parent, while another was very light purple with green apex and stripes even when very immature.

B 2 which contained no fresh admixture of either parent, showed a marked tendency to revert to the light form. With three exceptions the fruits were much lighter colored than the parent. Two plants bore fruits of a dark green ground color with apex nearly white and dotted and splashed with purple; while another bore very light green fruit with splashes of purple fading to a yellowish green at maturity.

B 3 showed very plainly the double influence of Giant Purple. In no case was the immediate parent perpetuated. The plants were exceedingly vigorous; leaves large, considerably lobed. Fruit ovate—about 6 inches long and 4 inches in diameter—very dark purple, almost black. Two plants bore fruit with lighter apex, but the very light forms seen in B 1 were not present.

B 5 very closely resembled B 3 in form and color but with greater tendency to light apex. The fruits were very handsome—often 9 inches long and 4 inches in diameter. B 7 was exceedingly variable both in form and color—the latter ranging from very dark purple through all gradations to light green with white apex and no trace of purple.

Selections from all of the above types were again made, but most of the fruits failed to ripen and were lost. Those saved were grown the past season and gave the following results: B 1 (a)—a selection from B 1, bearing purple fruits shaped like Giant Purple—retained the form of its immediate parent but was exceedingly variable as to color, many of the fruits being dull green with white apex and stripes, others irregularly splashed and mottled with purple. B 5 (a) also showed a marked tendency to revert to the white form. The parent was in no case perpetuated and no valuable form appeared. B 7 (a)—selected from the light type of B 7 in 1891—in no case gave a suggestion of the purple color of the Giant Purple. The form was oblong-pyriform, about 3 1-2 by 6 inches. Aside from the very small sorts this selection was

the most prolific sort grown, but its color would condemn it as a market sort. A specimen of this type is shown as No. 7 in the frontis-piece.

SERIES C.

Long White X *Black Pekin*.—In 1890, the first generation, the effect of the staminate parent was very marked in giving color to the foliage, much more so than was the case in series A in which the male parent was also Black Pekin. The plants were uniformly tinged with purple, and in some instances the color was nearly as dark as in the male parent. The fruit was of intermediate color with the purple predominating, but in form was quite variable. Some individuals resembled the staminate parent, other the pistillate, and others were entirely distinct.

This was the least promising of the series and though four fruits were again crossed or selected, but one, C 4, was brought by the writer to Maine. Of the others, grown at the Cornell Experiment Station in 1891. Professor Bailey reports: "In these lots the fruit pollinated from the same plant, C 1, gave a variable and very unproductive offspring. C 3, into which Black Pekin has gone twice gave only purple fruits."*

C 4 was not artificially pollinated, but was selected because of its excellent form, being almost cylindrical with very abruptly rounded ends. Seeds were sown in 1891 and of the resulting plants only two showed a tendency to perpetuate the type of C 4, and these failed to mature fruit. There was a variation in the direction of both of the original parents but in general the plants were of the type of the previous generation.

Selections were again made, and in 1892, there was almost complete reversion to the original male parent in the habit and color of the plants. They were hardly distinguishable from the plants of Black Pekin in adjacent rows. The form of the fruit, however, was still quite variable.

Conclusions as to Effects of Crossing: As a result of four years of breeding, we have as yet obtained no type sufficiently constant in color to be of commercial value. We have found, however, a marked increase in vigor and productiveness as a result of crossing.

---

* Bulletin 49 Cornell Univ. Exp. Sta., Dec., 1892, p. 344.

In the first generation the purple-fruited types seem stronger in their power to transmit color to the offspring than do the white-fruited types; and this law appears to hold whether the purple type is used as the male or as the female parent. In later generations the inherent strength of the white-fruited types appears more strongly than in the first; for in the third generation, after the purple type had twice entered the cross, the effect of the original white parent in imparting color to the fruits was more marked than in the first generation.

In all cases the white-fruited types appear stronger in the power to transmit form and productiveness.

Summary.

1. With careful treatment the egg plant may be successfully grown in Maine. The most important requisites of success are: Early sowing; vigorous plants; late transplanting to the field; warm, rich soil; thorough cultivation; constant watchfulness for the potato beetle.

2. The best varieties for this latitude are Early Dwarf Purple, Early Long Purple, Long White, and possibly Black Pekin. Other large varieties are too late.

3. The chief advantage derived from the crossing of the different races of egg fruits appears to be in the increased vigor and productiveness of the offspring. No valuable market sorts have as yet been developed.

FRUIT TESTS.

The winter of 1891-2, was very mild and little injury was done in the fruit plantations. All varieties made a good growth during the season, and as far as practicable the vacancies in the orchard, caused by the previous severe winter, were filled. Several additional varieties of pears, also of cherries were obtained, and a plum orchard has been established. The small fruit plantation has also been largely increased in extent.

The fruit plantations are now systematized, and maps and well defined forms for records have been constructed, thus rendering the plantations more valuable, for purposes of study and avoiding danger of confusion.

The additions to the experimental orchards and small fruit gardens the past season consist of the following:

Apples 5 varieties; pears 8 varieties; plums 13 varieties; blackberries 2; currants 3; dewberries 1; gooseberries 2; raspberries 11; strawberries 14.

With the exception of a few varieties of raspberries and blackberries, there is as yet no basis for a comparison of the merits of different varieties for this region. As soon as the various sorts come into bearing, more detailed reports may be made for the benefit of planters.

The work of securing valuable sorts that will stand the trying climate of the northern part of the state is being continued on an extended scale. During the past season cions of the following varieties have been sent to Perham, Aroostook Co.: Arthur, Borst, Duchess Seedlings number 4 and number 8, North Star, Patten's Greening from C. G. Patten, Charles City, Iowa; Daisy, Gideon number 6, Malinda, McMahon, Okobena, Ostrakoff, Patten's Greening and Utter from J. S. Harris, LaCrescent, Minnesota; Hibernal, Korsk Annis, Red Queen, Repka from Wm. Somerville Viola, Minnesota; Palouse from Geo. Ruedy Colfax, Wash; Rolfe, Maine State College.

Besides the above named cions, two year old trees of the following varieties were kindly donated by the Jewell Nursery Co. of Lake City, Minn. Thompson's seedlings numbers 24, 26, 29, and 43. As was the case last season part of these cions were set in bearing trees and part in seedling stock raised from Duchess seed.

The season was a favorable one for young stock, and all varieties made a vigorous healthy growth. None of them were taken up in the fall, and as the present winter is a very severe one with little snow, the test as to hardiness will be a crucial one.

The following varieties of Russian plums, purchased from the Iowa Agricultural College in 1891, were also placed on trial the present season: Bessarabian, Early Red, Hungarian Prune, Moldavka, Orel Sweet, Varonesch Yellow, White Nicholas, Nos. 19, 20 and 23 Orel; besides these one tree each of Cheney, Wolf and and Wyant from the same source and Rollingstone from O. M. Lord, Minnesota City, Minn. All of these last named sorts are valuable varieties of the hardy native *Prunus Americana*, originating in the trying climate of the northwest. It is our purpose to increase the list of plums next season and if possible by crossing some of these very hardy sorts with others of higher quality secure desirable sorts which shall rank with Moore's Arctic as a profitable variety for this region and possibly shall not require the winter protection demanded by that variety.

There is little doubt that with proper management small fruits might be made even more profitable in the northern parts of the State than in the southern, as at this latitude the crop ripens so late as to escape more southern competition. With this end in view, a number of varieties are being introduced. Some are already grown at Houlton—notably the Houghton gooseberry and the Agawam blackberry, but so far as I can ascertain little is being done even in the home gardens of northern Maine toward raising other small fruits.

Last spring plants of Windom and Lucretia Dewberry and of North Star Currant were sent to Perham for trial. Others will be sent later.

At the present time an effort is being made to determine the exact status of the fruit industry in the State, especially in the more southern portions, that we may have a basis for intelligent work in developing this line of work. A report on this subject will be published during the ensuing year.

SPRAYING EXPERIMENTS.

The work of spraying to prevent the attack of the apple scab was continued on the same line as last year, both Mr. C. S. Pope of Manchester and Mr. C. E. Moore of Winthrop, co-operating. The season was very unfavorable and it was difficult to find a suitable time for the work. In nearly every instance rain fell within twenty-four hours after the spraying was completed. As a result, the effects of the fungicides were somewhat modified and were less striking than those obtained last year.

Results in Mr. Pope's Orchard.

In Mr. Pope's orchard the work was of sufficient extent to warrant very free conclusions from a commercial point of view. The orchard is situated on a gravelly hill-side having a northwestern exposure and has been very subject to the attack of the fungus for some time.

The main object in view in this work was to determine the relative values of different solutions and to study the effects of applying the mixture at different times.

To this end, instead of single trees, given different treatment, contiguous rows extending down the hill-side were selected. In this way all rows presented essentially the same conditions, part of the trees being on high land and part on low. This matter of location is of the highest import since it has been observed—in this orchard and some others I have studied—that trees on high exposed situations are apparently more subject to attack than are those on lower ground.

Three solutions were used in the test as follows:

Solution A. Modified *eau celeste*, consisting of two pounds copper sulphate, two and one-half pounds carbonate of soda, one and one-half pints ammonia and thirty gallons water.

Solution B. Five ounces carbonate of copper, three pints strong ammonia, fifty gallons water.

Solution C. Three ounces carbonate of copper, one pound carbonate of ammonia, fifty gallons water.*

* For directions as to preparation of mixtures see Rep. Maine Ex. Sta., 1891, p. 116.

To be doubly sure of results, duplicate series were used. In this way we have two rows in different parts of the orchard sprayed with each solution; while for comparison three rows alternating with these were left without treatment. Naturally all of the trees were not equally productive, and in counting the fruit only those trees which were under approximately the same conditions were selected.

Because of the large number of trees to examine it was impossible to count all of the fruit from each tree, hence five basketfulls, or two and one-half bushels were taken from all parts of each tree.

Table VIII gives the results obtained from the first series, and table IX those from the second.

TABLE VIII.

Solution.	Average number fruits examined.	Free from scab.	Slightly scabbed.	Badly scabbed.	Per cent. free.	Per cent. No. 1 apples (as regards scab).	Remarks.
"A".......	563	219	332	14	39.00	97·6	Average of four trees.
Check............	681	0.6	203	477	0.09	30·1	" " five "
"B".............	550	47	410	93	8.50	83·7	" " " "
"C".............	663	24	429	209	3.73	68·6	" " " "
Check............	663	0·6	207	425	0.12	35·5	" " " "

TABLE IX.

Solution.	Average number fruits examined.	Free from scab.	Slightly scabbed.	Badly scabbed.	Per cent. free.	Per cent. No. 1 apples (as regards scab).	Remarks.
Check............	633	0.6	207	425	0.12	35·5	Average of five trees.
"A".......	552	123	361	67	23.6	88·3	" " four "
"B".............	637	12	290	336	2.1	49·8	" " three "
Check............	556	17	324	215	3·1	62·1	" " four "
"C".......	535	46	388	101	8.9	81·7	" " three "

The superiority of the fruit on trees treated with solution *A*—modified *eau celeste*—is seen at a glance; while solutions B and C do not appear widely different. With a single exception the average increase of marketable fruit as a result of the treatment ranges from 19 to 60 per cent. Row "B" in table IX was a short row and contained one tree which was very badly attacked—only 27.6 per cent. of the fruit being "No. 1"—thus bringing the average below that of the adjoining check row, which was better than the average.

Combining the results obtained in the duplicate trials, these facts stand out even more clearly, as seen in table X.

TABLE X.

Solution.	No. examined. Average per tree.	Free from scab. (Average).	Slightly scabbed. (Average).	Badly scabbed. (Average).	Per cent. free. (Average).	Per cent No. 1 apples (as regards scab). (Average).	Remarks.
"A".......	559	171	347	41	30·1	93·0	Average of 8 trees.
"B"............	583	34	365	184	6·1	71·0	" " " "
Check..........	615	32	414	169	5·6	73·5	" " " "
"C"............	628	5	239	384	0·93	41·2	" " 14 "

As will be observed, the average proportion of "No. 1" fruit on unsprayed trees—considering fourteen trees in all parts of the orchard—was only 41.2 per cent. of the crop; while the average proportion on trees sprayed with the least effective solution was 71 per cent., a gain of nearly 30 per cent. With the modified *eau celeste* this difference was much more marked, amounting to nearly 52 per cent., or a saving of more than half of the total crop.

The amount of fruit absolutely free from scab is not as large as might be wished; but the standard adopted in sorting the fruit was very rigid, and much of that classed as "slightly scabbed" was in reality better fruit than that classed as "free." It was observed, however, that fruit from the trees sprayed with *eau celeste* were frequently russetted, as though the solution was too strong.

With these figures in view, and considering the fact that the results are in direct confirmation of those obtained last year, there would appear to be little doubt as to the effectiveness of the treatment when the work is properly conducted.

The value of duplicating any experiment of this kind is well shown by comparing tables VIII and IX. Table VIII gives data which would apparently warrant drawing very positive conclusions as to the relative merits of the different solutions; while table IX would appear to reverse the relative positions of solutions "B" and "C," and even indicates that solution "B" is of little if any value. But by combining the data we approximate nearly the true results.

When Shall we Spray? A part of the work in Mr. Pope's orchard was conducted with a view to determining the best time for applying fungicides, as well as the relative value of several applications. To this end some trees were sprayed but once, early in the season; others were sprayed twice, some three times and some four times; while some trees were not sprayed. Solution "B" was used in every instance.

The results of this trial are shown in table XI.

TABLE XI.

No. times sprayed.	Number fruits examined.	Free from scab.	Slightly scabbed.	Badly scabbed.	Per cent. free.	Per cent. No. 1 apples (as regards scab).	When sprayed.
Once	499	13	314	172	2.6	65.6	May 26.
	497	1	161	335	0.2	32.6	
	481	12	301	168	2.5	65.1	
	604	0	212	392	0.0	35.1	
	600	4	267	329	0.7	45.2	
Average per tree	**536**	**6**	**251**	**279**	**1.2**	**48.7**	
Twice	688	0	287	401	0.0	41.7	May 26, June 23.
	610	2	314	294	0.3	51.8	
	542	26	355	161	4.8	70.3	
	556	0	237	319	0.0	42.6	
Average per tree	**599**	**7**	**298**	**294**	**1.3**	**51.6**	
Three times	583	30	439	114	5.1	80.3	May 26, June 23. July 21.
	617	38	455	124	6.2	79.9	
	684	27	432	225	3.9	67.1	
	485	36	360	89	7.4	81.6	
Average per tree	**592**	**33**	**421**	**138**	**5.6**	**77.2**	
Four times	588	21	346	221	3.6	62.4	May 26, June 23, July 21, Aug. 20.
	438	45	292	101	10.3	76.9	
	552	18	372	162	3.2	70.6	
Average per tree	**526**	**28**	**337**	**161**	**5.7**	**70.0**	
Three times	559	6	315	238	1.1	57.4	June 23, July 21. Aug. 20.
	707	7	285	415	1.0	41.3	
	462	25	300	137	5.4	70.3	
Average per tree	**576**	**13**	**300**	**263**	**2.5**	**56.3**	

There is a very noticeable difference in the percentage of good fruits on adjacent trees when treated in the same manner. But trees sprayed three or four times are more uniformly good than those sprayed once or twice. As seen in the table, in the row sprayed once, there is a difference of more than 32 per cent. in the amount of fruit on the second tree, and that on the trees on either side—a difference frequently noted on the unsprayed rows. In the rows treated twice this difference is not quite so marked; while in the rows sprayed three or four times the greatest difference is only about 14 per cent., the lowest percentage being nearly equal to the highest on the trees sprayed but once.

By comparing the last division of the table with the third, it will be observed though each row was sprayed three times the average quality of the fruit is much lower in the former case, the average per cent. of No. 1 fruit being 56.3, as opposed to 77.2 in the third row. That is, the indications point strongly to the value of spraying *early*. The two rows in question were under essentially the same conditions, being parallel and separated by only one row, which was sprayed four times, but the first was sprayed once before the blossoms opened, while the other was not sprayed till June 23.

The results obtained are not conclusive, but in general they point to the value of repeated applications and to the desirability of spraying early in the season.

Results in Mr. Moore's Orchard.

To check our work still further, arrangements were made with Mr. C. E. Moore of Winthrop to continue the work of the previous year in this direction. Mr. Moore's orchard is usually very badly attacked, and would seem to be an excellent field for work. The trees bore very heavily in 1891, however, and were not as well adapted for our use as they otherwise would have been. Those trees which bore but little fruit are not considered in compiling the tables, as such trees are seldom attacked so severely as are those which bear a full crop. As will be observed, the character of the fruit on the different trees is very unequal; that on some trees being either excessively scabby or remarkably free from scab, while that on other adjacent trees may represent the opposite extreme. Thus it follows that the average percentages as given in the tables do not always represent the true average condition of the trees, especially is this the case when a larger number than common is taken from any one tree. As before noted, however,

the amount of fruit was so variable, that in order to get proportionate quantities from the different classes, it was impossible to adopt an inflexible rule as in the first orchard considered.

But two solutions were used in Mr. Moore's orchard viz : Solutions "B" and "C" described on page 92.

In comparing the two solutions a number of trees were sprayed four times each, on May 26, June 15, July 15, and Aug. 15, or as near these dates as possible. Rain followed soon after each application, and the results are not striking, as seen by table XII.

TABLE XII.

Treatment.	Number fruits examined.	Free from scab.	Slightly scabbed.	Badly scabbed.	Worthless.	Per cent. free.	Per cent. No. 1 apples (as regards scab.)	Remarks.
Solution "B"....	1892	8	829	797	348	0.4	42.2	Always one of the worst in the orchard. Very full; fruit small; ¾ of whole counted.
Sprayed 4 times.	839	138	493	183	25	16.4	75.2	All the fruit taken. Opposite Check No. 3.
	456	28	359	61	8	6.1	84.9	All the fruit.
Average.........	**1092**	**58**	**560**	**347**	**127**	**5.3**	**56.6**	
Checks...........	577	9	318	227	23	1.6	56.7	Small tree; light crop.
	2334	6	1175	927	226	0.3	56.0	All the fruit counted; opposite No. 1, solution *B*.
	1006	0	415	565	26	0.0	41.2	¾ of all counted.
Average.........	**1306**	**5**	**636**	**573**	**93**	**0.4**	**49.1**	
Solution "C"....	522	6	246	224	46	1.1	48.3	All the fruit.
Sprayed 4 times.	854	24	415	382	33	2.8	51.4	¾ of all.
	1047	20	542	469	16	1.9	53.7	¾ of all.
Average.........	**808**	**17**	**401**	**358**	**32**	**2 1**	**51.7**	

As will be observed the average results are slightly in favor of the sprayed trees as compared with the unsprayed, while solution B gave slightly better results than did solution C, the average increase in No. 1 fruit being 5.5 per cent. in the former case and 2.6 per cent. in the latter. The percentage of fruit absolutely free from scab is very low in every instance, but in a general way the work has some value in that it confirms the results obtained in Mr. Pope's orchard.

Number of Applications.

Some of the trees in Mr. Moore's orchard were sprayed twice with solution B, and others three times, while others in close proximity were left as checks. Trees sprayed four times were

under somewhat different conditions and can not be compared with these.

Table XIII shows the results obtained from this trial.

TABLE XIII.

No. times sprayed.	Number fruits examined.	Free from scab.	Slightly scabbed.	Badly scabbed.	Worthless.	Per cent. free.	Per cent. No. 1 apples (as regards scab).	Remarks.
Twice.........	696	28	452	195	21	4.0	**68.9**	All the fruit counted.
	917	35	620	252	10	3.8	**71.4**	About ½ the fruit. Adjacent to first tree sprayed three times.
	529	231	278	30	00	42.9	**94.5**	All the fruit.
Average............	**717**	**98**	**450**	**159**	**10**	**13.7**	**76.4**	
Three times.......	833	73	574	168	18	8.8	**77.7**	All the fruit.
	787	78	491	206	12	9.9	**72.3**	¾ of all; very good.
	970	55	764	151	00	5.7	**84.4**	About half; small.
Average............	**863**	**69**	**610**	**175**	**10**	**8.0**	**78.8**	
Checks......	1006	00	415	565	26	0.0	**41.2**	¾ of all.
	839	38	485	265	51	4.5	**62.3**	All the fruit.
	774	98	531	120	25	12.7	**81.3**	" " "
Average..... ...	**873**	**45**	**477**	**317**	**34**	**5.1**	**59.8**	

A single tree in the first group being exceptionally free from scab, the average percentage of fruits absolutely free is brought higher than in the other cases; but the average proportion of fruit which would be classed as "No. 1" is greater on those trees which were sprayed three times. With a single exception the amount of "No. 1" fruit on all sprayed trees is considerably greater than that on unsprayed trees, the average increase being 16.6 per cent. on trees sprayed twice, and 19 per cent. on those sprayed three times.

SUMMARY.

1. Spraying with copper solutions proves an effective means of checking the apple scab.

2. The average increase in the amount of salable fruit on the trees sprayed with the least effective solution over that on the unsprayed trees was 30 per cent. while the increase on trees sprayed with *eau celeste* was nearly 52 per cent.

3. *Eau celeste* proves more effectual than does the ammonio-copper carbonate solution but as used there was a slight injury to surface of the fruit.

4. Indications point strongly to the value of spraying early in the season, before the blossoms open.

5. Repeated applications of the fungicide during the season are beneficial.

Report of Botanist and Entomologist.

Prof. F. L. Harvey.

Prof. W. H. Jordan.

Dear Sir :—I have the honor to submit herewith my fifth annual report as Botanist and Entomologist for the Experiment Station. Judging from the number of letters received the past season, asking questions about plants, insects, fungicides and insecticides, there is an increased demand on the part of farmers in the State, for information upon Economic Botany and Entomology. Below will be found tabulated the more important plants and insects that have received attention during the past season. Those requiring more than a passing notice are considered in detail, and so far as necessary illustrated.

The past season has been somewhat remarkable because of the appearance in the State in injurious numbers of several insects that have not before been reported, viz : The Corn or Boll worm, which was found in the vicinity of Farmington feeding on sweet corn ; the Chinch Bug, doing great damage to grass grounds in the vicinity of N. Fryeburg ; the Horn Fly which proved quite annoying to cattle in the western part of the State, and *Bruchus obtectus*, *Say*, the Bean Weevil, boring in stored beans after the manner of pea weevils in peas.

We stated in our report for 1891, that the Fall Canker Worm had been increasing in the Penobscot valley for the past four years, and that considerable trouble might be expected from it in the future. It has proved very troublesome the past season about Winterport, Bowdoinham and Stockton, doing great damage to fruit and shade trees. We learned through a Vermont correspondent that the Apple Maggot, *Trypeta pomonella*, Walsh, infests pears in that State. As we have never seen it working in pears in Maine any information on the subject from Maine orchardists will be appreciated. We received specimens of the Melancholy Cetonia (*Euphoria melancholica*,) from Mr. John A. Smedberg, Unity, which were eating sweet corn at the top of the ear. So far as we know this habit has not been recorded. The Oyster-Shell Bark-louse must be doing great damage in Aroostook County

judging from the badly infested specimens of apple twigs received from David Crane of Houlton. Those interested in this insect will find it considered in Expt. Sta. Rept. 1888, p. 157.

The Three-toothed Aphonus, accused of cutting corn in our last report, has been fully convicted of the charge the past season, by Mr. C. V. Manley of Auburn. He says, "I found this beetle which I send you, in a hill of corn with his head in a cut in the side of a stalk that had begun to wilt."

Mr. E. W. Merritt of Houlton, reports that he keeps the plant lice on his gooseberry bushes in check by removing the twigs bearing curled leaves in the fall. We have received insects during the past season from Illinois and California sent for determination by the editor of the Maine Farmer. Investigation of a species of mite called by us the Two-spotted Mite has been continued. This mite has done considerable damage the past season in the greenhouse at the college, and we found it had almost entirely destroyed a patch of German Wax Beans in our garden. Should it prove able to injure to any extent out of door plants, its capabilities of doing damage would be greatly enhanced. As we were doing laboratory work on the mite, it might have been carried to the beans on our clothing. We wish to study the coming season, insects affecting currant and gooseberry bushes, and will be pleased to receive specimens from all parts of the State.

We received from Mr. Ira Porter, Houlton, Maine a bunch of clover, *Trifolium medium*, L., in which the heads had assumed the form of conpound umbels. This was interesting as a confirmation of the belief by botanist, that the head, a kind of inflorescence found in the clover, is an umbel with the axis of inflorescence and the pedicils, shortened. Mr. Henry Sprague of Charlotte, for whom we examined some mosses last season in reference to their value as food for swine, reports that he fed during the winter about six barrels of *reindeer moss*, four of *hypnum splendens*, two of *sphagnum cymbifolium*, to three *swine*.

As the pigs all had other food he had no definite way of telling how much nutriment they got from the mosses. Thinks they liked either of the others as well as the reindeer moss. Thinks all had a constipating effect, which he overcame by liberal doses of sulphate of magnesia (salts).

Mr. W. H. Burgess of Monroe, says, that he grafts the Arctic and Lombard plums into the common Pomgranite and avoids the black knot, which has proved so destructive to plum trees in general. We don't know how thoroughly the experiments were tried, but

have serious doubts about its being a protection. We doubt whether any of the varieties are exempt from this disease, though we admit that such a variety would be a great blessing to plum growers. We received from Mrs. Myra Damon, Newport, Maine, a specimen of Stinkhorn found in a cistern. These plants grow in decaying organic matter and are often found about sink spouts, drains and other places where decomposing organic matter occurs. They may be known by their curious habit of growth. At first they look like a puff-ball, finally the top bursts and from it comes a large spongy stipe which bears at the apex a slimy mass of brownish offensive spore bearing matter. The bottom part (utricle) of the form sent is about as large as a filbert, the stipe pink and three or four inches long. Finding it about the cistern would lead one to suspect that a sink spout or drain was too near, and that the water might be contaminated by it. These fungi are poisonous, but a single one in a cistern would not render the water harmful. Too great care cannot be exercised in placing drains and sink spouts where they cannot possibly contaminate water supply, as decomposing organic matter in drinking water is a very common source of diseases.

Samples of sage sent by Mr. Willard Lothrop, of Leeds Centre for examination as to adulterations, proved to be free from foreign matter, but were composed largely of old stems and poorly cured and blackened leaves. As to color and richness of flavor, the material was quite inferior, and would give dark color and poor flavor to sage cheese.

Walter M. Haines M. D., of Ellsworth, sent us some specimens of Fresh water cord Grass, and asked whether they were not Wild Rice. Wild Rice was sown quite largely in the marshes and ponds of Maine some years ago to attract water fowl, but so far as we know it has not become established in the State. If any one knows of its occurrence in the State, we would be glad to learn the localities. Mr. Fernald gives it in his Portland Catalogue as indigenous to the State, but we do not know the locality.

The Orange Hawkweed is spreading rapidly in the State and threatens to be a serious pest in meadows and pastures. Farmers should study the description given in this report, and be prepared to recognize the pest as soon as it appears, and destroy the straggling plants before they form large patches hard to manage. Below we give an extended account of the most important plants that have claimed attention during the past season.

The Potato Rot has been quite bad in the State the past season. We hope that potato growers will see the importance of using Bordeaux mixture to hold this disease in check. It has proved a great help in other States when applied at the time, or just before the disease makes its appearance.

REMARKS.

The cuts and plates to illustrate this report were obtained from the following sources: from the Department of Agriculture, Washington, D. C.; Cuts of the Orange Hawkweed, and of the Horn Fly. From Prof. S. A. Forbes, cuts of the Corn Worm and Chinch Bug. From Prof. F. D. Chester, cuts showing the results of spraying against Pear Leaf Blight. Plate II. is original.

Directions for sending specimens will be found in the Annual Report of the Experiment Station, 1888, p. 194, or in Maine Agricultural Report, 1888, p. 158. Correspondence regarding injurious insects and fungi is invited. Insects and plants will be named, and when injurious, remedies suggested. It is to the interest of farmers to detect injurious insects and fungi before they become established, so that remedial measures can be adopted before the pests are beyond control. As the Entomologist's duties prevent him from going much about the State, it is largely through correspondence that the Station learns of insects doing injury in the State.

INSECTS REPORTED AND EXAMINED—1892.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	Cecropia Emperor Moth.	Platysamia Cecropia, Linn.	Ross C. Higgins, Thorndike. M. H. White, Bowdoinham.	Cocoons attached to branches of apple trees. See Ex. St. Rept. 1890, p. 121.
2	Fall Canker Worm.	Anisopteryx pometaria, Harris	M. H. White, Bowdoinham. Hon. F. Atwood, Winterport. Freeman Partridge, Stockton.	Eggs attached to apple trees, larvæ upon foliage, male and female moths about orchard. See Ex. St. Rep. 1888, p. 166.
3	Fall Web-worm.	Hyphontria cunea, Drury, = H. textor, Harris.	Ross C. Higgins, Thorndike.	Foliage of apple trees making a web at the ends of the branches. See Ex. St. Rept. 1890, p. 124
4	Corn or Boll-worm.	Heliothis armigera, Hub.	J. M. S. Hunter, Farmington. D. H. Knowlton, Farmington.	Boring through the husks and eating the kernels from the cobs of sweet corn.
5	Melancholy Cetonia.	Euphoria melancholica, Gory.	John A. Smedburg, Unity.	Eating sweet corn at the top of the ear.
6	Three-toothed Aphonus.	Aphonus tridentatus, Say.	C. V. Manley, Auburn.	Cutting off stalks of sweet corn in the hill. See Ex. St. Rept. 1891, p. 199.
7	Plum Curculio.	Conotrachelus nenuphar, Herbst.	H. T. Cummings, S. Paris.	Pears badly punctured by this insect. See Ex. St. Rept. 1888, p. 178.
8		Pasimachus species.	Ross C. Higgins, Thorndike.	On the ground; a beneficial species feeding on other insects.
9	Scabrous Osmoderma.	Osmoderma scabra.	Ross C. Higgins, Thorndike.	Found on an apple tree. Larvæ bore in apple trees.
10	The Squash Bug.	Anasa tristis, De Geer.	S. Dill, Soquel, Cal.	Feeding on squashes.
11	The Chinch Bug.	Blissus leucopterus, Say.	W. B. Nutter, B. Walker McKeen, Simeon Charles, N. Fryeburg.	Destroying Timothy meadows.
12	Currant Worm.	Nematus ventricosus, Klug.	H. H. Osgood, Blue Hill.	Eating foliage of currant bushes. See Ex. St. Rept. 1888 p. 182.
13	Oyster-shell Bark-louse.	Mytilaspis pomorum, Bouchè.	David Crane, Houlton.	Badly infesting the branches of apple trees. See Ex. St. Rept. 1888, p. 157.
14	The Horn Fly.	Haematobia serrata.	Hon. B. W. McKeen, Augusta.	Troublesome to cattle.
15	Two-spotted Mite.	Tetranychus 2-maculatus, n. sp.	Prof. L. H. Bailey, Ithaca, N. Y., and others.	A bad pest in hot houses and also affecting house plants and sparingly out of door plants.
16	Wood Louse, or Sow Bug.	Porcellio species.	Henry Raffe, Orono.	Mistaken for the Buffalo Carpet Beetle. Lives on decaying wood and organic matter.
17	Long Horned Wood-borer.	Monohammus tittilator, Fabr.	O. F. Brigham, Newport.	A wood borer.

Plants Received for Examination—1892.

No.	Common Name.	Scientific Name.	From Whom Received.	Remarks.
		WEEDS.		
1	Fall Dandelion.	Leontodon autumnale, L.	Henry Norcross, Augusta.	Weed in meadows.
2	Orange Hawkweed.	Hieracium aurantiacum, L.	Geo. W. Chamberlain, Calais. H. L. Leland. E. Sangerville. G. S. Paine, Winslow.	Weed—meadows, roadsides and pastures.
3	Canadian Hawkweed.	Hieracium Canadense, Michx.	I. T. Merrill, China.	Border of fields; not a bad weed.
4	Knapweed.	Centaurea nigra, L.	I. T. Merrill, China.	Weed in fields; should be looked after.
5	Rabbit-foot Clover.	Trifolium arvense, L.	I. T. Merrill, China.	Weed—roadsides, etc.; very common in Maine.
		GRASSES.		
6	Red Top.	Agrostis alba, L. Var. vulgaris. Thurb.	S. H. Berry, Wayne.	Sold by Parker & Wood. Boston, as Kentucky Bluegrass. (*Poa pratensis*. L.)
7	Freshwater Cord-grass.	Spartina cynosuroides, Willd.	Walter M. Haines.	Sent to learn whether it was wild rice.
8	Orchard Grass.	Dactylus glomerata.	Joseph F. Warren, W.Buxton.	Growing in grass ground.
		FUNGI.		
9	Pear Leaf Blight.	Entomosporium maculatum, Lev.	Arthur D. Moore, Portland.	Parasitic on leaves of pear trees causing them to curl, turn red and drop; a bad disease.
10	Hair Mold.	Phycomyces nitens.	N. H. Martin, Fort Fairfield.	Growing on excrement of cats in a potato hill. Not of special economic importance.
11	Anthracnose.	Glæosporum venetum, Speg.	Chas. S. Pope, Manchester.	Raspberry bushes badly infested.
12	Anthracnose.	Glæosporum venetum, Speg.	H. H. Osgood, Blue Hill.	Affecting Shaffers Collosal Raspberry.
13	Stinkhorn.	Mutinus Ravenelii, (B. and C.) Fisch.	Mrs. Myra Damon, Newport.	Found in a cistern. An offensive, poisonous species.
		MISCELLANEOUS.		
14	Zigzag Clover.	Trifolium medium, L.	Ira J. Potter, Houlton.	Heads changed to compound umbels Flowers malformed and dwarfed.
15	Golden Rod.	Solidago squarrosa. Muhl.	E. F. Hitchings, Bucksport.	Sent for verification.
16	Golden Rod.	Solidago latifolia, L.	E. F. Hitchings, Bucksport.	Sent for verification.
17	Aster.	Aster acuminatus, Mx.	E. F. Hitchings. Bucksport.	Sent for verification.

BOTANY.

Fall Dandelion.

Leontodon Autumnale, L.

(Ord. Compositæ.)

The above species continues to be reported as troublesome in grass lands. It has a firm hold in the State, and should be known by farmers so they can check it before a whole field is overrun. When there are only a few plants, the extermination is a simple matter, but if neglected serious trouble will follow. Much of the clover seed offered for sale in this State contains the seed of this weed.

The following reply to Mr. Henry Norcross may interest others.

Mr. Henry Norcross of this city, brought a specimen plant to this office for identification. He says his fields are infested with it, and that it is killing out the grass far and near. We forwarded the sample to Prof. Harvey, Botanist at the Experiment Station, who kindly forwarded the following to the *Farmer:*

The plant you enclose for determination belongs to the sunflower family (*Compositæ*) and is called by botanists, *Leontodon autumnale*, *Linn.* Its common name is Fall Dandelion. The Latin name means the *Liontooth that blooms in the autumn.* The leaves are incised, suggesting the name of liontooth. The plant is a native of Europe, but is thoroughly naturalized in the United States, and quite widely spread. It is especially plentiful in New England, and a bad weed. Being an abundant seeder and a perennial, it is hard to exterminate. It grows under the most unfavorable circumstances, and will replace grasses in meadows. Should it become too abundant, there is no way to destroy it excepting cultivation in some hoed crop until it disappears. The plants about roadsides, edges of fields and lawns, should be pulled by the roots, or kept from seeding by careful mowing. In this region it is abundant along the roadsides, and is increasing. Occasionally a field is noticed nearly overrun with it. Roadsides are prolific seed gardens that supply the public gratis with an abundance of seeds of the vilest weeds. The town authorities should be empowered by law to exterminate patches of weeds that appear, and might become the centres of distribution of troublesome pests. This weed will be found figured and described in Experiment Station Report, 1890, p. 120.

F. L. Harvey,

Botanist for the Station.

Orono.

Orange Hawkweed.

Hieracium aurantiacum, Linn.

(Ord. Compositæ.)

The following letters were received the past season at the Station regarding the above plant. They show how rapidly the weed is spreading, and what a bad pest it is regarded by farmers. The plant has been found in limited quantities on the College farm in a pasture near the river, and has not spread very much in that place but the past season we noticed it in several places in the meadow land. Mr. James Walker of Bangor, reported a field of several acres near Pea Cove, nearly overrun with it. Mr. George W. Chamberlain reports it from Calais. These together with the localities given in the following letters show it is widely distributed in the State. The question so pointedly asked by Mr. Paine, whether "*we are at the mercy of our neighbors in the matter of spreading weeds*" is one that should seriously claim the attention of the legislature. There should be a law preventing farmers from harboring vile weeds in their fields or letting them grow at the roadsides on their premises. On property for which no one is especially responsible, the dangerous weeds should be eradicated at public expense. Why do not farmers urge some enactment for their protection? There should be a law subjecting seed sold in the State to inspection. The character of the seed sown is as important as the composition of the fertilizer used.

Winslow, Me., June 20, '92.

The State Agricultural College,
For the Prof. of Botany,
Orono, Me.

Dear Sir:—About two years ago I sent you, I think, a plant found in this vicinity which you identified as the Orange Hawkweed. It was not regarded as a dangerous weed at all. I wish to give my experience with it and ask if there is any way to compel farmers to stamp out such weeds under our law. I have fought it on this farm for about five years. It comes from a farm one-fourth miles square, two narrow farms intervening, and these farms are getting rapidly stocked with it. I have watched it with the greatest care and have picked it clean the middle to the last of June, and again scoured the fields after the haying and at frequent intervals till fall. In spite of the greatest care it is

L. R. Stowell del.

O. HEIDEMAN, SC.

ORANGE HAWKWEED
(*Hieracium aurantiacum*, Linn.)

gaining on me, and when these other farms are well covered I shall have to give it up. I am surrounded by the wild carrot, and have no difficulty in keeping it off the farm, but the Hawkweed, one of the vilest to the smell, seems almost impossible to eradicate. In my opinion, if its behavior indicates anything, it is the most dangerous weed that has threatened us, not excepting the Canada thistle. Will you be kind enough to inform me if we are at the mercy of our neighbors in the matter of spreading such weeds? A line from you will greatly oblige

Yours very respectfully,

G. S. PAINE.

EAST SANGERVILLE, ME., July 1, 1892.

BROTHER BALENTINE:

Find enclosed a plant (weed) that is rapidly encroaching into fields and pastures. It is known locally as *Missionary* weed. Its mission however is one not to be desired. The weed is described in the Report of the United States Department of Agriculture 1890 under the name Orange Hawkweed. This plant is rapidly spreading in the county from many different points. A recent trip in the town of Guilford and Foxcroft showed many fields completely overrun. The village streets and numerous grass flats in Foxcroft village are painted red with this weed. In fact it is a *monopoly* plant taking full possession of the soil, and destroying everything else. Do you know whether the weed is common in the State? It seems to me it cannot be, as I do not remember to have seen anything said of it in the Agricultural papers. Can you or any of your associates tell us how successfully to fight it? If you know aught of it, and methods of eradication please give them to me for publication in the Piscataquis Observer.

The rapidity with which this weed is taking possession of our fields is alarming to our farmers.

Truly, H. L. LELAND.

REMARKS.

This weed has recently been introduced into the Eastern United States from Europe. It has been in Maine on the College farm for at least ten years, and according to Mr. Paine, about Winslow for more than five years. We have no knowledge of the time or place of its introduction in the State. Such things are scarcely ever noticed until they do injury, when it is often too late or very troublesome to eradicate them. The experience of Maine farmers

shows that the plant does not confine itself to roadsides and pastures, where the grass is short, but encroaches into meadows and overruns them. The plant being a perennial and developing runners and root-stocks, makes it a very difficult weed to control. Nothing short of destroying the roots will suffice. Besides, it is so hardy and tenacious of life that it takes almost complete possession of the soil. It is prolific of seeds, which are provided with a row of bristles (pappus), giving it the power of wide dissemination by the wind. We will be pleased to hear from anyone who has noticed this weed and to learn how long it has been known or anything regarding its introduction in the State. On the opposite page we give a cut of this weed and below a description, both copied without change from the United States Department of Agriculture, Report for 1890. They will enable anyone to recognize this vile weed.

"Perennial by slender root stocks and by runners; Stem simple, erect, one to one and one-half feet high, nearly leafless, densely hirsute, the hairs toward the apex of the stem black at the base; leaves mostly radical, oblong-lanceolate, denticulate, hirsute on both sides, sessile, those of the stems two or three; all but the lowest reduced to bracts; heads in a bracted cyme; peduncles with black, glandular hairs and a close brown coating of stellate hairs; involucre about one-third of an inch in diameter, its bracts linear-lanceolate, little imbricated, provided on the back with straight, glandular and stellate hairs; flowers all perfect, with ligulate orange-covered corollas; achenia about one line long, darkbrown, linear in outline, terete, ten-ribbed, truncate; pappus a row of dirty white bristles."

Leaf Blight of the Pear.

Entomosporium maculatum, Lev.

Attention has been called to the above fungus as doing damage to the leaves and fruit of pear trees in Maine.

The letters from Mr. Moore given below will indicate the nature of the inquiries. Mr. Moore's pear trees are located upon Diamond Island, Portland Harbor.

May 24, 1892.

Horticulturist Maine Experiment Station.

Dear Sir:—I enclose a few leaves from my Clapp's Favorite pear tree.

The leaves began to have this appearance two seasons ago, on one branch of the tree. Last year more branches were effected, and this year it seems to have spread over the whole tree. Is it Pear blight? and is there any remedy?

Yours Respectfully,

Arthur D. Moore.

The above letter shows how rapidly this disease spreads, and the necessity of applying remedial measures as soon as possible. We recommended the use of the ammoniated carbonate of copper solution, made as follows:

Dissolve three ounces of carbonate of copper in two quarts of commercial ammonia water (22°) and dilute with water to thirty-five gallons.

Fig. 1. *Tree not sprayed.*

The first application should be made when the leaves are half grown and repeated according to the severity of the case every three or four weeks during the season.

Fig. 2. *Showing beneficial effects of spraying.*

The experiments made by Mr. Chester of the Delaware Experiment Station, in 1891, show that the carbonate of copper and carbonate of ammonia solution is cheaper, as well as one of the most effective of the copper compounds used as fungicides. It is made as follows: Mix three ounces of carbonate of copper with one pound of pulverized carbonate of ammonia; dissolve in two quarts of hot water and dilute further with water to fifty gallons. Figures 1 and 2 show the relative condition of sprayed and unsprayed trees.

Mr. Moore made the following report:

Jan. 3, 1893.

Prof. F. L. Harvey,

Dear Sir:—Yours of the 27th at hand. I sprayed my pear trees with the ammonia and copper carbonate solution, according to directions as nearly as possible, June 13 and again July 16.

The fungus had already appeared when the first application was made, but it did not spread nor seem to kill the leaves as much as the year before. The leaves remained upon the trees this year until the usual time, whereas in '91 that part of the tree affected was entirely bare for a month before it should have been. I think the spraying has been of great benefit and will eventually cure the disease.

I thank you very much for your kindness to me, and for the interest you have taken in the matter. I also wish to thank you for the reports which you so kindly sent me. I have enjoyed them very much and have found much in them of value to me.

I will write you again in regard to the pear trees when the leaves appear next spring.

Yours respectfully,

Arthur D. Moore.

P. S. The spraying seemed to stop the disease just where it was. In '91 it spread all over the leaf and seemed to burn it all up, so that they were all dead by the last of August.—A. D. M.

Characters of the Fungus.

This fungus causes a premature discoloration and dropping of the foliage and in some cases the spotting and cracking of the fruit. It has done considerable damage to pear and quince orchards. It does not seem to be as bad in Maine as in the Atlantic States farther South, but it is here and should be known and precautions taken to prevent its spread. Sometimes the leaves all drop early, but usually they drop slowly during the season. The leaves are unhealthy, the trees do not make a normal growth and sometimes a second blossoming occurs.

The disease first shows itself in the form of minute red spots, which increase in number and size and finally cause the leaf to shrivel and drop. The tender twigs are affected and often destroyed. The disease upon the fruit causes it to crack, through which germs enter and cause early decay.

Black or Hair Mold.

Phycomyces nitens.

We received the above-named fungus from Mr. Martin, and as the species is quite common in Maine we give Mr. Martin's letter and an account of the plant.

Fort Fairfield, Me., March 31, 1892.

Friend Jordan,

Dear Sir:—Enclosed with this letter you will find a piece of an elephant potato, to which is attached a hairy mane.

In the same hill there grew seven potatoes, all of which had a hirsute growth similar to the enclosed.

Will you please let me know whether this is the much-sought-for missing link, or what it may be?

This has elicited much curiosity and we would like to know of what nature it is.

Respectfully yours,

N. H. Martin.

The above-named mold belongs to an order of fungi known as *Mucorini* or *Black Molds.* The species of the genus *Mucor* are quite common on decaying organic matter and are frequently seen on rotten potatoes, squashes, pumpkins and other vegetables in the garden and in the cellar. They also are very annoying to housewives, appearing quickly upon bread, or cooked vegetables

kept in warm, moist places. They may readily be known by their smoky black color, and the dense, erect coating of fine thread-like fibres with which they cover the substance attacked. These fibres bear at the ends small, round head like fruits, that are filled with small, oblong bodies called *spores*, capable of reproducing the mold. Where the fibres cross, spore-bearing bodies are also produced by a sexual process called conjugation. These spores have great vitality and will grow after they have been dried a long time. This accounts for their being everywhere. The spores are light and can be carried a long way by wind. A dry atmosphere is always prejudicial to their growth. The specimen sent by Mr. Martin is not a *Mucor*, but belongs to the genus *phycomyces* of the same *family*. It is quite common in Maine, but prefers oily instead of starchy substances to feed upon. We have frequently found it upon the excrement of cats, which was buried in dirt, or spent ashes out-of-doors, or more commonly in cellars that cats have access to, or under out-houses. The fibres of this plant are sometimes six or eight inches long and in dark cellars a beautiful, glossy black and wonderfully like hair in appearance. The specimens grown in more light, or in the laboratory, are less luxuriant and paler colored. The common species of *Mucor* are much smaller and shorter fibred. The spores of specimens kept in a dry laboratory for five years, germinated readily on bread in a moist chamber. This species of *phycomyces* showed streaming of cells contents (cyclosis) very nicely in a double current along the walls of the cells which joined at the end and flowed back down the centre.

The origin of the specimens sent by Mr. Martin was plainly the excrement of some animal that had been buried in the potato hill. The specimen submitted was growing on excrement, not on a piece of potato. If the potatoes of the hill were affected the fungus originated in the excrement and spread to them. This fungus is interesting, and is sure to attract attention, though it is not to be regarded as especially injurious.

Anthracnose of the Raspberry and Blackberry.

Glœosporium venetum, Speg.

Mr. Chas. S. Pope, of Manchester, Me., sent us the past season a bundle of raspberry canes badly infested with the above disease. He said: "My bushes are all dying with this disease.

They were obtained from a neighbor, who had them from Anderson, of N. Y. I find that my neighbor's are also dying with the same disease." Mr. H. H. Osgood, of Bluehill, reports the same disease as affecting his bushes of *Shaffer's Colossol* raspberry.

History. This disease was first considered by Prof. Burrell under the name "Raspberry Cane Rust," but it is now generally known as *Anthracnose.* It is a foreign species, but has become widely distributed in this country and does much damage to raspberries and blackberries.

Characters. It attacks the canes, leaves, petioles of the leaves, and in some cases the fruit. It attacks both the fruiting and non-fruiting canes. It first appears near the base of the canes as small, purplish spots. As the disease advances it encroaches upon the tops, and in the last stages will attack the petioles, leaves and fruit. The purplish spots enlarge and finally coalesce, producing irregular, light-colored, blister like patches, often over an inch long and sometimes encircling the stem, producing the same effects as girdling with a knife. The leaves and fruit are much dwarfed from a want of nourishment and finally the plants die. The disease lives over winter upon the young canes attacked and renews its ravages the next season.

The fungus producing these effects is a microscopic, internal, thread-like parasite, that creeps between the cells of the host plants, sapping their vitality. It does not usually enter the pith, but confines its ravages to the cells of the bark and cambium layer, causing them to shrivel and die. Near the centre of the diseased spots, where the ends of many of the capillary threads of the fungus meet and unite, are formed masses of short, club-shaped bodies called *basidia.* These are formed under the epidermis of the bark and finally burst it, appearing enveloped in a globule of gelatinous matter. Upon the ends of these basidia are borne singly, small, colorless, oblong, or oval celled bodies called *spores.* The spores are the reproductive elements and serve to spread the disease to adjoining plants and patches. The spores are held together in the gelatinous matter, which is soluble in water. The spores are liberated during rains and rapidly germinate in drops of water on the plants. Dry weather prevents the spread of the disease to new places, though the fungus will continue to grow in dry weather on canes where it is established. Spores liberated by rains are in a condition to be blown by the

wind after the rainwater evaporates. Spores taken from specimens kept in the herbarium for several months will germinate, showing the vitality of this parasite, and warranting the belief that the fungus will live over winter in the canes.

Precautions.

(*a*.) In the case of Mr. Pope's plants the disease was no doubt on the canes when planted and probably on his neighbors' bushes when they came from the nursery. We reiterate the importance of carefully examining nursery stock before planting it, to see whether it is affected by fungus or insect parasites. If found to be affected by a fungus it should be burned without delay.

(*b*.) As it seems quite certain that the spores of this disease survive the winter in old canes, those that are through bearing, or dead, or badly affected, should be removed at the close of each season and burned.

(*c*.) As moisture favors the growth of fungi the plants should be trained and framed so as to admit as free a circulation of air and light as possible. Planting in rows six feet apart and the plants five feet in the rows will admit plenty of light and air, and will admit of cultivation each way.

(*d*.) Spraying with a solution of sulphate of iron (green vitril) two pounds, to five gallons of water, before the buds start in the spring has been recommended.

(*e*.) Should the disease appear after the leaves are expanded the use of Bordeaux mixture is recommended.

Remarks.

Those who wish to read a fuller account of this disease will find it considered in the Report of the U. S. Department of Agriculture, 1887, page 357, and illustrated on plate V.

The Potato Blight.

Phytophthora infestans, De Bary.

To determine whether the germs of potato rot live over winter in the soil, or are planted in the seed, the following experiment was performed:

A quantity of rotten potatoes from a badly infested patch was gathered and buried in the ground under as natural conditions as

possible. The next spring, two lots of seed that had shown no evidence of rotting in the cellar, were selected and planted as follows:

1. Two rows, one of each kind of seed, on the ground where potatoes rotted badly the past season.

2. Two rows one of each kind of seed upon land that had not grown potatoes for two seasons.

3. Two rows planted as in lot 2, but each hill infested with the rotten potatoes buried the fall before.

All the rows were fertilized alike with phosphates and ashes.

Results.

The disease did not appear in any of the rows.

This would indicate, so far as one experiment goes, that the germs do not survive the winter in the soil, and would emphasize the importance of selecting seed free from the rot. We are not satisfied with the results and will repeat the experiment.

Bordeaux Mixture for the Rot.

Mr. B. Walker McKeen has experimented with Bordeaux Mixture the past season, to prevent potato rot and we give below his interesting and suggestive report.

AUGUSTA, Dec. 31st, 1892.

DEAR PROF. HARVEY:

In reply to your favor of yesterday, asking for my experience with the Bordeaux Mixture for potato blight, I will say, that I used the mixture quite thoroughly through the entire season, putting it on three times, but the results were not such as to warrant me in recommending it to farmers without another trial. I raised a very fine crop of potatoes, all of good size, and the rust did not affect them to any great extent. Still there were some other pieces quite near me that were not affected materially. Other pieces suffered quite badly. I am inclined to the belief, that a *liberal fertilization* of the ground for potatoes will tend to place them beyond the reach of the rust, and that in this way farmers may prevent its ravages, in a great measure. Still I am prepared to say that I shall *certainly* use the mixture another year, as I am not yet prepared to condemn it, as I certainly think my crop was increased by its use. I hope to be able to report more fully after another trial.

In addition to my own experience, I might say that I furnished a neighbor material enough to put upon a small part of his piece and that he used it but once, and he is willing to say that the tops where the mixture was used remained green much longer than those which had not been treated, the difference being so great that the neighbors in passing stopped to learn the cause; but the difference in the crop was not what he expected it would be, from the looks of the tops. He will use it largely next season.

Yours very truly,

B. WALKER MCKEEN.

In reference to the plan of liberal fertilization suggested by Mr. McKeen, it is well to remember that a patch of potatoes may be destroyed by potato blight in *two* ways. The germs of the disease may be in the seed, or in the soil upon which the potatoes are planted. In either case the germs would soon enter the young plants, grow with them and finally destroy them. In the second case the soil and seed may be *entirely free* from germs and the crop almost reach maturity and then becomes infested by *summer spores* blown from an adjoining patch and rapidly destroyed.

It is a principle, equally applicable to plant and animal life, that healthy specimens (all other conditions being equal) are stronger and better able to resist the attack of diseases and parasites. It is also a good rule to fertilize highly and feed animals well for by so doing the profits are greater.

It must be also remembered that plants under cultivation and animals under domestication make a more rapid growth than in nature, and that their tissues are much softer, and when once attacked by a fungus or parasite they become an easier prey.

If the higher fertilization of potato land will hasten the maturity of the crop, and thus prevent infection from the poorly fertilized lands of a shiftless neighbor, it would be an advantage.

If the germs are already in the patch, high fertilization would make the plants more succulent and give the disease a better hold.

An overgrown patch would also fall an easier prey to summer spores should they reach it at the right time.

We believe it is better to adhere to the rule, that *adequate fertilization is always best* and prepare ourselves to fight the parasites that are sure to attack the soft tissues of cultivated plants. The planting of early varieties would be an advantage, providing our neighbors grow the later sorts.

Bordeaux Mixture cannot destroy the potato rot in plants where it is established. It can only prevent the disease *spreading* by destroying the summer spores.

In experimenting with Bordeaux Mixture some rows in the patch should be left unsprayed to serve as a check.

Bordeaux Mixture is a fungicide of great promise and we hope others will try it and report the results.

ENTOMOLOGY.

Fall Canker-worm.

Anisopteryx pometaria, Harris.

(Ord. Lepidoptera: Fam. Phalenidæ).

This insect is increasing rapidly in the State. We have spoken in previous reports about its increase in Penobscot County, but it is also increasing in other counties. Mr. Freeman Partridge writes that it has done great damage about Prospect in Waldo County. Mr. C. A. Arnold, Arnold, Me., says: "They are the curse of my young apple trees, doing more damage to them by destroying the leaves and blossoms than all other insects combined." The shade and orchard trees about Orono were badly infested the past season. The garden fences in some parts of Orono were literally covered with egg clusters. As the insects feed largely on the tall elms and other shade trees and forest trees, there is no hope of exterminating them by confining our remedial measures to the orchard. We must take steps to keep them out of shade trees or they will continue to breed there and transfer their depredations to the orchard.

Mr. Partridge says the Canker-worms have troubled him for three years, increasing each season. Though the spraying done did not kill the Canker-worms it did destroy the *Codlin Moths*. He says he did not find a bushel of apples affected by this insect in his whole orchard, while he has had them in abundance before. This would indicate that the time to spray for Codlin Moths was about the time the Canker-worms are grown. We suggested the use of a band around the tree to prevent the *wingless females* ascending to lay their eggs. Mr. Partridge writes: "There is a bug nearly as big as a house fly that is crawling on the trees. I

send you two. The little wingless bugs are lively on the south side of the trees though the snow is three or four inches deep among the trees." The insects spoken of above were the wingless females of the Canker-worm.

Remedies.

We would advise a trial of a tin band, which consists essentially of a band or circle of tin a few inches outside of the trunk of the tree, held there by a circle of muslin attached to the tin at its edge and drawn with a cord at the top, so as to fit the tree closely and prevent the insects from getting up without going over the tin. The tin is kept covered with a mixture of equal parts of castor oil and kerosene. As soon as they touch this they fall to the ground. The muslin can be fastened to the tin by turning over the edge of the tin before it is bent to a circle and inserting the edge of the muslin and hammering them together. The tin should be about three inches wide and long enough to stand out three or four inches from the tree, when bent around it and fastened by rivets. The whole inner surface of the tin is daubed with the mixture of castor oil and kerosene. The mixture should be renewed occasionally and the bands kept on the trees until the moths disappear. Fig. 3 shows the nature of the band and the way to attach it. Should the trees be full of eggs or young caterpillars then spraying would have to be resorted to.

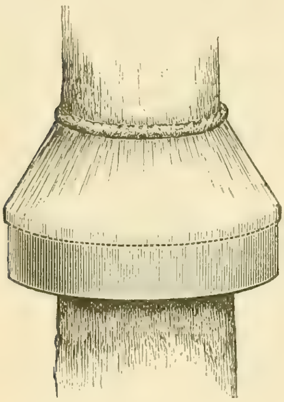


Fig. 3.

Mr. Partridge believes in thorough work and sprayed, using one-half pound Paris green to a barrel of water, consequently the leaves of Tallman Sweets were injured. He speaks of the flower buds of his trees being eaten, apparently before they open. This may have been done by the *Eye-Spotted Bud Moth;* see Sta. Rept. 1888, p. 169, also Rept. 1890, p. 128. The spraying should be done early enough to catch the young worms before they do much damage to the foliage. The time can be determined by watching a few clusters of eggs and when they are hatched the mixture should be applied, or to be safe two sprayings could be made, one just as the leaf buds are bursting and another a week later. While the leaves are young and tender we would advise a weak mixture, say one pound to two hundred gallons. It is a great shock to a tree to loose its

foliage if it is not killed. The leaves are the food formers for the plant. They elaborate the food necessary to make the new wood and perfect the fruit, also it is their office to store, in the new wood and buds, the material necessary to form the leaves the next season. *It is important* to clear the trees of leaf-eating insects as early in the season as possible.

The reader will find an account of the habits of this insect in Expt. Sta. Repts. 1888, p. 166, and 1890, p. 137.

There is an insect closely related to the Fall Canker-worm known as the Spring Canker-worm. It differs principally in spending the winter in the ground, emerging very early in the spring and laying its eggs which soon hatch. The Fall Canker-worm changes to the moth state in the fall when the eggs are laid and do not hatch until spring. We have not noticed the Spring Canker-worm to any extent in Maine. We have at present to do with the more abundant one.

The females of both species are wingless, and as both feed on the foliage, spraying would be equally remedial for both. For the spring species bands would have to be applied in the spring. The bands on the trees in the spring would prevent the young caterpillars of both species climbing the trees.

The Boll-worm or Corn-worm.

Heliothis armiger, Hübn.

(Ord. Lepidoptera: Family Noctuidæ).

Last September we received a package of sweet corn from Mr. John M. S. Hunter of Farmington, Me., and the following communication:

Chronicle Office,
Farmington, Me., Sept. 10, 1892.

Sir:—I send you by express to-day a box containing ears of sweet corn. A gentleman in this village planted the corn (sweet corn) in his garden. He tells me every hill is affected and corn in same condition as that which I send you. Will you please look it up and tell the readers of my paper what these worms are and how to exterminate them. This is a great sweet corn region and farmers fear these worms will give them trouble.

John M. S. Hunter, Editor.

About the same time we received specimens of the same insect from Mr. D. H. Knowlton, Farmington, Me., and learned from other sources that it was doing considerable damage to sweet corn in that vicinity.

The ears of corn received, each contained from one to half a dozen worms, snugly concealed beneath the husks at the top of the ears, that were feeding on the kernels. In some of the ears the kernels had been eaten nearly clean on the upper third of the cob. In some of the ears the worms had eaten most of the silk, and in others holes were gnawed through the husks at various places. We at once recognized the worms as the larvæ of the Cotton Boll-worm, an insect that has done untold damage to cotton, corn and various other crops in the West and South. This insect has done more damage in the Southern and Middle States than in the extreme Northern, but judging from the specimens received, it finds congenial conditions in the sweet corn fields of Maine. There is reason for serious concern regarding it, for if it maintains itself and increases, it will jeopardize the corn packing industry.

The damage done is not confined to the kernels eaten. The sap exudes from the kernels gnawed and ferments, so that it would be impossible to use the affected ears for canning. The exuded sap invites a host of smaller insects and fungi to share in the spoils. The husks being left open by the worms eating the silks, allows rains and dew to enter and favor the growth of moulds.

It would not pay to examine carefully each ear to see whether it harbored worms, small insects or fungi before cutting it for canning. Practically a crop much infested by this insect would be worthless for canning, and would have to be utilized so far as possible as food for stock.

If the insect confined its ravages to corn alone it might have a hard time to perpetuate itself on account of the sweet corn being gathered before the worms have their growth. Some of the worms in the corn sent were not more than one-third grown, others were half grown and only a few mature. We put them in a breeding cage and the smaller ones lived until December and died without entering the pupa state, while the larger ones remained gnawing the ears for several weeks before entering the ground.

We are inclined to think the larvæ may in some cases hybernate. The insect is quite a general feeder having been known to do much damage to peas, beans, pumpkins, tomatoes and tobacco, and probably has still other food resources. It should be care-

ully watched for the next two seasons, and if it shows a tendency to increase and spread, concerted action should be taken to exterminate it. That the insect may be known when seen, we give below a condensed description of it in the various stages of its life history and also cuts of the eggs, larva, pupa and moths.

Description.

Eggs—nearly globular, a little flattened at the base, with a slight depression at the top and a series of depressions running from this depression to the base ; diameter .025 inches ; color pale straw. The moths are said to be capable of laying five hundred eggs which are placed singly upon the leaves by the first brood, and upon the silks and husks at the top of the ear by the later brood. The time required to hatch is supposed to be from two days to a week. Two views of the eggs magnified are shown in Fig. 4, a and b.

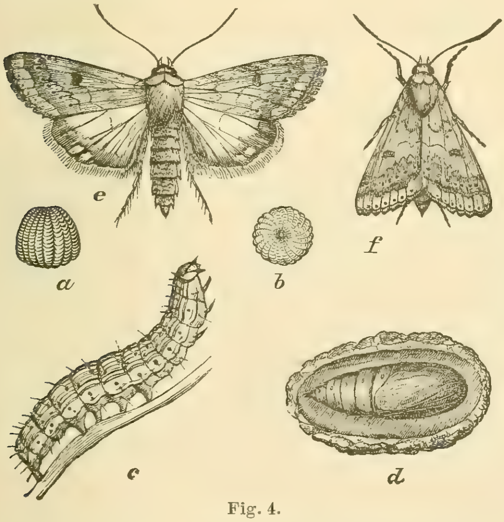


Fig. 4.

Larva—length 1.5 inches when full-grown ; color variable, some being pale brown, striped with darker brown, others pale green striped with darker green. There is a dorsal brown band bordered by a narrow light line followed by a darker band that reaches to just above the breathing pores (stigmata) while the stigmata are in a light area that extends to the ventral surface which is of the general body color. On each segment are eight shiny black spots from which arise brown hairs. The four black spots on the back of each segment are arranged in the form of a trapezoid, with the parallel sides transverse with the body, the shortest side toward the head. The two black spots on the sides are just above the stigmata, one above and in front, the other back and on a line with them. Head and legs brown, shield on

the neck (cervex) dark brown. A few short hairs scattered over other parts of the body. See Fig. 4, c. When full grown the worm enters the ground, forms a cocoon of earth interwoven with silk and changes to the chrysalis.

Chrysalis—length .8 of an inch. Color light chestnut brown, the dorsal line, stigmata and divisions of the segments darker. Rather slender, an indentation on the back where the abdominal segments begin, the last four segments moveable, two thorns at the extremity. See Fig. 4, d, which shows the chrysalis in the cocoon.

Moth—expanse of wings 1.5 inches. The color is quite variable in depth of shading. The more common color of the fore wings is pale clay yellow, with a faint greenish tint, and marked with darker olive, dark brown, or even black. A dark, conspicuous spot near the middle of each fore-wing. Hind wings paler with a dark brown band along the outer margin interrupted in the middle by a large pale spot.

The moth with expanded and closed wings is shown in Fig. 4, e and f.

Life History.

In Maine there is probably only one brood of the moths, at least we have no evidence bearing upon the subject to indicate more than one. The moths probably are on the wing early in August. (The larvæ we received on September 10th were of various sizes, some full grown, and though we have not taken the moths in Maine we know the larvæ require three or four weeks to mature, and the eggs several days to hatch which would require that the moth be on the wing early in August). The small worms found in the corn received were from eggs laid on the same ears later, requiring that the moths continue on the wing for some weeks or the time of emerging from the chrysalis extends over considerable time.

The moths mate and the females lay their eggs probably one in a place upon the food plant. They are on the wing early in the evening. The eggs are laid upon the leaves, tassels, silks or husks and hatch in a few days. The worms gnaw through the silk at the top of the ears and feed upon the kernels forming channels at the top of the ears. They will gnaw holes through the silk and go to other ears on the same stalk or even go to new hills. After feeding about three weeks or longer according to the season and

the weather, they are mature and make their way to the ground choosing preferably a spot where the earth is compact, burrow beneath the surface making a round hole which widens toward the bottom and is slightly closed at the top. In this gallery they change to the pupa state. Where there is only one brood they hybernate in the pupa state and appear the following season and the round of life is complete.

Remedies.

Natural.—Bacterial diseases of the worm, moth and eggs are known, besides a half dozen or more insect parasites, Tachinas Ichneumons, prey upon them in the larval state. Lady birds, several species of hyemenopterous insects, tiger and ground beetles prey upon them, and chalcid egg parasites on the eggs. Bats and other insectiverous animals eat the moths. Insectiverous birds and barnyard fowls are fond of them and destroy both worms and moths. Ants and spiders destroy the eggs and young. It is also well known that they will eat each other.

Artificial.—In the extreme North where there is probably but one brood this insect would be more easily checked than where there are two or three broods in a season. Where there are several broods a few survivors of the winter would in the last brood become numerous.

The single brood of Maine could be managed by deep fall ploughing of corn lands to break up the burrows and expose the chrysalides to the effects of fall rain and winter freezing. If a field is found badly infested it would be better to feed the corn green to stock than to allow the worms to mature and enter the ground. Infested ears should never be left in the field so the worns can leave them and crawl into the ground. When possible crush the worms found with the hand.

Any one wishing to look up this insect farther will find a condensed article in the Fourth Report of the United States Entomological Commission, p. 355, which is finely illustrated with colored drawings of the worms and moths.

The Chinch Bug.

Blissus leucopterus, Say.

Ord. Hemiptera: Subord. Heteroptera: Fam. Lygæidæ.

During the past season the following letters were received:

Scarboro, Aug. 23rd, 1892.

Prof. Balentine:

My Dear Sir:—I sent you a small lot of insects from North Fryeburg, on Aug. 8th. I did not know how badly they were destroying the grass, but find they have spread over a large part of the town of Fryeburg, and that the farmers are at complete loss to know what to do to stop their spread. Any advice you can give them would be very thankfully received. I saw Brother B. W. McKeen on Saturday last, and told him what I had done. He was not aware that the damage was so great, as the bugs had not got to his section. Nathaniel Frye, Fryeburg Centre, John Batchelder, or John Hastings, North Fryeburg, would probably give you any information asked for.

Yours respectfully,

W. B. Nutter.

Scarboro, Maine.

Prof. F. L. Harvey,
Orono.

My Dear Sir:—Your very kind letter of the 24th at hand, and contents noted. The bugs you speak of were collected in a field in my own town. They have been found there in years past, and have done considerable damage at times. Can you give me their origin, habits and remedy, if there is any? They work in the grass roots, particularly Timothy hay, which they completely destroy. Thanking you for your information, I am

Yours very truly,

B. Walker McKeen.

We answered Mr. Nutter's letter informing him that the specimens sent were immature forms of the Chinch-bug. We also wrote Mr. McKeen and asked him to secure for us some mature specimens of the insect so as to make its indentification positive, and the following letters were received in answer:

SCARBORO, Aug. 29, 1892.

PROF. F. L. HARVEY:

MY DEAR SIR :—Yours of August 26th at hand. In explanation of my sending the bugs to Prof. Balentine, will say I was on a business trip to Fryeburg and seeing the damage the bugs were doing I thought it the quickest way to find out what they were and what to do to destroy them, to send to headquarters. I did not know of anyone except Prof. Balentine to apply to. I have written B. Walker McKeen in regard to the matter and hope you will be invited to make a visit to North Fryeburg and make an investigation. I feel that the matter is quite serious and demands the attention of the State officials to keep it within bounds and to stamp it out if possible.

I have written to Simeon Charles at North Fryeburg to send you some of the bugs in alcohol, and have also written to Nathaniel Frye at Fryeburg Center, asking them both to give you any information they can in regard to the time of the first appearance of the pests, and also how extensive they have become.

Yours truly,

W. B. NUTTER.

SCARBORO, Maine.

PROF. F. L. HARVEY:

MY DEAR SIR :—Your letter received, and I have sent to Mr. S. C. Charles, North Fryeburg, for further samples. Think he has some of the full grown ones in alcohol. I find some of our Fryeburg farmers claim the bugs have been seen here occasionally for many years, twenty-five or thirty, at least.

B. WALKER MCKEEN.

NORTH FRYEBURG, Sept. 6, '92.

PROF. F. L. HARVEY:

DEAR SIR :—Brother Nutter wrote to me about those bugs that he sent you, saying you thought them to be the chinch-bug. I have got some in a vial which I shall send by this morning's mail. They have worked here for years. Friend Batchelder thinks they were here twenty-five years ago, but did but little damage. They are confined to the intervale wholly—have not been on the upland at all. They have not meddled with anything but herd grass and red top until this fall, when they got on the sweet corn ; but have injured it but slightly. Hoping to hear from you and some remedy for the pest, I remain,

Yours truly,

SIMEON CHARLES.

AUGUSTA, Sept. 8th.

PROF. HARVEY:

MY DEAR SIR:—I forward you this letter from Brother Charles. Please acknowledge receipt. Make a *full* investigation. If you plan to go to Fryeburg let us know.

Yours very truly,

B. WALKER MCKEEN.

NORTH FRYEBURG, Sept. 8, '92.

BROTHER MCKEEN:

DEAR SIR:—Received your letter last night. I sent the bugs the 6th. They seem to be going in an easterly direction. I think from what I can learn they are on the Hobbs' intervale. Mrs. Hobbs' boy told me about his grass. No doubt they are at work on it. Hoping to find some remedy,

Yours truly,

SIMEON CHARLES.

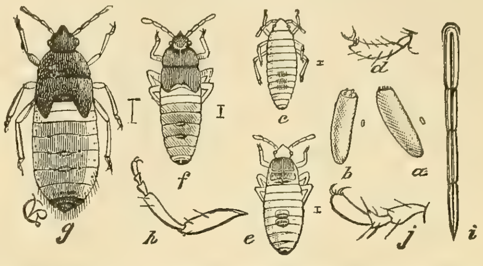
We were not able to visit the infested area without leaving class-room work at the college, and it was decided not to do so. Last fall we published a short article in the *Maine Farmer* announcing the occurrence of this insect in the State and suggested burning over the infested fields if possible. It will be desirable this season to learn the extent of the infested district, and we will be pleased to hear from all who may know of its occurrence even in small numbers upon their farms. That the insect may be known when seen, we give below a description of it in all the stages of its life history and suggest such remedies as have been tried in the West and South and have proved at all beneficial.

The information given below has been gleaned from the experiences of Riley, Forbes, Osborn, Gillette and others who have carefully studied the insect and remedies.

DESCRIPTION.

Eggs—Average length .03 in. elongate-oval, the diameter scarcely one-fifth the length. The top squarely docked and bearing four rounded tubercles near the center. Pale whitish and translucent when laid, but becoming amber colored with age, and finally the red parts of the enclosed embryo and the eyes show through. The eggs grow somewhat after being laid. See Fig. 5, a and b, which shows the eggs both natural size and magnified.

Fig. 5.



Chinch-bug, Larva, Pupa and Egg. *a* and *b*, eggs; *c*, young larva; *d*, tarsus of same; *e*, larva after first molt; *f*, larva after second molt; *g*, pupa; *h*, leg; *i*, beak or tubular mouth; *j*, tarsus of mature bug.

Larval stages.—The newly hatched larva (Fig. 5, *c*) is pale yellow, with simply an orange stain on the middle of three larger abdominal joints. The form scarcely differs from that of the mature bug, being but slightly more elongate; but the tarsi have but two joints (Fig. 5, *d*) and the head is relatively broader and more rounded, while the joints of the body are subequal, the prothoracic joint being but slightly longer than any of the rest. The red color soon pervades the whole body, except the first two abdominal joints, which remain yellowish, and the members, which remain pale. After the first molt (Fig. 5, *e*) the red is quite bright vermilion, contrasting strongly with the pale band across the middle of the body, the prothoracic joint [first behind the head] is relatively longer, and the metathoracic joint [third behind the head] shorter. The head and prothorax are dusky and coriaceous and two broad marks on the mesothorax [second joint behind the head], two smaller ones on the metathorax, two on the fourth and fifth abdominal sutures, and one at the tip of the abdomen are generally visible, but sometimes obsolete; the third and fourth joints of the antennæ are dusky, but the legs are still pale. After the second molt [Fig. 5, *f*] the head and thorax are quite dusky and the abdomen duller red, but the pale transverse band is still distinct; the wing-pads become apparent, the members are more dusky, there is a dark red shade on the fourth and fifth abdominal joints, and ventrally a distinct circular, dusky spot covering the last three joints.

Pupa—[Fig. 5, *6*]. In the pupa all the coriaceous parts are brown-black, the wing-pads extend almost across the two pale abdominal joints, which are now more dingy, while the general color of the abdomen is dingy gray; the body above is slightly pubescent, the members are colored as in the mature bug, the three-jointed tarsus is foreshadowed, and the dark, horny spots at the tip of the abdomen, both above and below, are larger.

Perfect Insect (Say's description).—Blackish, hemelytra white with a black spot. Body long, blackish, with numerous hairs; antennæ, rather short, hairs; second joint yellowish, longer than the third, ultimate joint longer than the second, thickest; thorax tinged with cinerous before, with the basal edge piceous; hemelytra (elytra) white, with a blackish oval spot on the lateral middle; rostrum and feet honey-yellow; thighs a little dilated; length less than three twentieths of an inch.

Fig. 6.

Chinch-bug, The short line below shows natural length.

(Le Baron's description.)—Length 1 2-3 lines, or three-twentieths of an inch. Body black, clothed with a very fine, grayish down not distinctly visible to the naked eye; basal joint of the antennæ honey-yellow, second joint the same, tipped with black, third and fourth joints black; beak brown; wings and wing-cases white; the latter are black at their insertion, and have near the middle two short, irregular black lines, and a conspicuous black marginal spot; legs dark honey-yellow, terminal joint of the feet and the claws black.

Life History.

The *mature bugs* hybernate and may be found during the winter months under grass, dead leaves and rubbish, in the field and about thickets and timber adjoining the infested area. When the weather is warm enough in the spring they emerge from their hiding places and after finding suitable food plants for their young deposit their eggs. This probably occurs in May in Maine, but we have not had opportunity to determine when they begin to move. Each female is said to be capable of laying about five hundred eggs, and oviposition extends over twenty days. After the eggs are laid the bugs live some time and may do damage before they die. The eggs hatch in due time and the young pass

through the larval stages described above and finally pass into the pupa stage. Bugs hatched in May become mature in July when after pairing eggs for a second brood are laid. In July there is usually a flight of the bugs to new fields and by this means the infested area may be greatly extended. The second brood reaches maturity in the fall and by cold weather is ready to seek winter quarters, completing the life history.

REMEDIES.

It is well known in the West and South where the Chinch-bug has done so much damage, that there are Chich-bug years, when climatic conditions combine to favor the rapid increase of this pest. A wet, backward spring and well distributed summer rains are known to destroy the eggs and young of the first brood and prevent the great increase of the second brood later in the season. The correspondence given above shows, that the pest has been in Maine in the infested district for a great many years, and it has not done serious damage until the past season. The conditions last year were probably a dry time while the eggs and young of the first brood were maturing and they survived in greater numbers than usual and gave rise to a much larger second brood. The coming season may be unfavorable for them and no great injury occur. The heavy rain fall of Maine will probably protect this State from such severe scourges as some of the Western States with less rain fall have suffered. The Chinch-bug seems very much adverse to fresh water baths and does not flourish in moist climates, upon very wet lands, or upon luxuriant crops that shade the ground and keep it moist.

The correspondence shows that the area is increasing and the matter is serious enough to demand careful attention. There should be concerted action upon the part of the farmers of the infested district. Whatever remedy is adopted to check this injurious insect will be of little avail unless it is a combined effect of the entire population in the infested district. One of the great difficulties is to secure concert of action. There are improvident farmers in every neighborhood who harbor weeds and injurious insects and will not destroy them, and there is no law to compel them. Public opinion and moral suasion are the only available levers. Below we suggest some remedial measures that may be applicable in Maine.

a, *Clean Culture.*—As the Chinch-bug hybernates under rubbish, etc., and those that survive the winter determine the number to lay eggs the following season; hence all rubbish and other material about the fields under which they can find shelter should be removed.

b, *Ploughing.*—When a grain field is badly infested it should be ploughed deep immediately after harvest before the bugs can migrate to adjoining crops. The land should be ploughed at least six inches deep and turned as nearly upside-down as possible. By this means a great many young bugs will be destroyed. We do not know whether the bugs have attacked grain fields in western Maine. This remedy would be applicable to a meadow as well as grain field if there was no objection to breaking it up. It is well to harrow and roll the land after ploughing to harden the surface and make it more difficult for the bugs to crawl out. If the bugs are found very numerous along the border of a meadow or in small patches in the field it would be well to plough these places early in the season and in two or three weeks sow to a late crop. Fall plowing is advisable, and if rubbish, straw, manure, etc., are placed on the field the bugs will crawl under it for shelter and be ploughed under. In plowing the use of a jointer is advised as it causes the surface of the ground to be more thoroughly buried.

c, *Burning.*—When the grass or grain stubble is dense enough or dry enough, the entire field should be burned over after harvest. If the bugs are found in a meadow in the fall, that you wish for grass the following season, and the stubble will not burn, then wind-rows of straw or swamp-hay should be put across the field. The bugs will seek shelter under them, when they should be burned early in the morning or late in the evening. The burning should be carried to all other places where they are known to be hybernating.

d, *Miscellaneous Remedies.*—*Early planting* and *heavy sowing* and good *fertilization* have been found important aids in the West to hold this pest in check. The Chinch-bugs only feed upon members of the grass family and rotation of grain with buckwheat clover, peas, beans, or other root crops would starve them out. In the West they sow strips of millet, of which the bugs are very fond, and after they gather upon it it is cut and the ground immediately plowed deep and rolled. Various insecticides have been used with more or less success, but they are omitted as perhaps of no application to checking the insect in Maine.

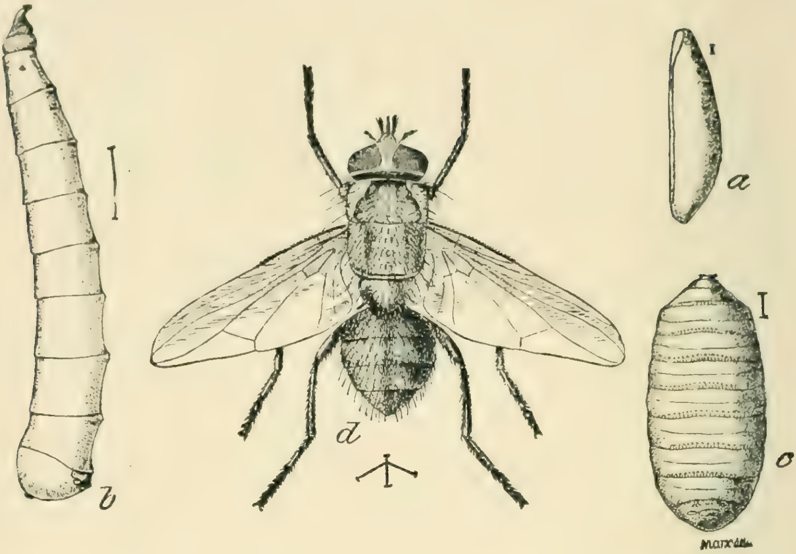


Fig. 1.

Fig. 2.

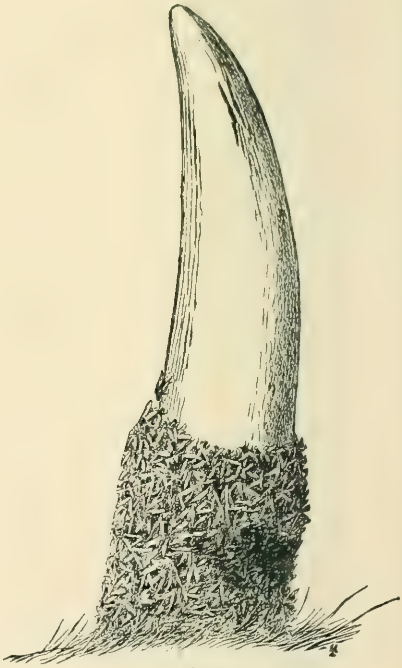


Fig. 3.

THE HORN FLY.

(Hœmatobia serrata.)

Fig. 1. *a* Egg; *b* Larva; *c* Puparium; *d* Adult in biting position—enlarged. Fig. 2. Adult in resting position—enlarged. Fig. 3. Flies in resting position at the base of the horn—reduced.

THE HORN FLY.

(Hœmatobia Serrata, Robineau Desvoidy.)

Ord. Diptera: Fam. Muscidæ.

We received the following letters regarding the occurrence of the Horn Fly in Western Maine:

AUGUSTA, Aug. 27, '92.

PROF. HARVEY:

MY DEAR SIR:—The Buffalo Horn Fly has been very troublesome in Fryeburg and vicinity, so much so that I have used Kerosene Emulsion (Weed formula) on our cows to protect them from their very sharp bites.

Yours very truly,

B. WALKER MCKEEN.

NORTH FRYEBURG, Sept. 6, '92.

PROF. HARVEY:

DEAR SIR:—We are having a visitation of the *Horn Fly*. Can you give us any information in regard to them? They do not appear to bite the cattle very much and do not annoy the horses at all, but they come in immense numbers and over a large territory at once. Yours truly,

SIMEON CHARLES.

REMARKS.

This is a European species first noticed in this country in 1887, in the vicinity of Philadelphia. From that point it was spread both to the north and south but more rapidly southward, and now occurs from Canada to the Gulf, west to the prairie states and Texas. The first report of its occurance in Maine was September, 1882, in the vicinity of North Fryeburg, Western Maine. We have not observed it in the Penobscot Valley.

Below we give a condensed account of the life history and such remedies as have been suggested. Those who wish to study the insect more in detail will find it considered in Insect Life, Vol. 4, No. 2, Washington Government Printing Office, 1892, and in U. S. Agrl. Rept., 1889, page 345.

The flies resemble the house-fly in general appearance but are only about half as large. While feeding the wings are spread at an angle of about 60° (see Fig. d) and elevated.

LIFE HISTORY.

The reddish brown oval eggs Fig. a. are laid during the warmer parts of the day, singly and usually upon their sides upon the

surface of the dung immediately after it is voided, the time of oviposition occupying about a minute. The eggs hatch and the larvae (Fig. 1 b.) descend intothe dung, remaining near the surface. When ready to transform the larvæ descend to the ground beneath the dung and enter it from a half to three-quarter of an inch, or if hard probably transform on the surface to the puparium. (Fig. 1 c.) In from ten to seventeen days from the time the eggs are laid the flies appear. (Fig. 1, d.) There are probably seven or eight generations annually in the middle or southern latitudes, but probably a less number in Maine. The fly makes its appearance in May or June and becomes most abundant in July and August, dwindling as cold weather approaches. It probably hybernates in the pupa and adult stages. The flies, when abundant and especially early in the season, collect about the base of the horns of animals to rest, hence the name.

Damages.

The milk of milch cows is reduced in quantity and animals for the shambles rapidly loose flesh. The irritation due to the bites causes the animals to rub themselves, producing sores. The flies bite the animals and suck the blood.

Remedies.

Protective Applications.—Almost any greasy substance wil keep the flies off for several days. Train oil or fish oil alone, or with a little sulphur or carbolic acid will keep the flies off for several days. Tallow has been used to good advantage. Common axle grease will answer nearly as well. These should be applied on the parts of the body most frequented.

Applications to destroy the fly.—A spray of kerosene emulsion directed upon a cow would kill all the flies it happened to touch. Dusting the cows with pyrethrum or some other dust insecticide, as tobacco, is recommended.

Applications of insecticides intended to check the pest by destroying the flies are hopeless against the immense swarms of them.

How to destroy the early stager.—Thoroughly lime the dung or spread it so it will dry. This will destroy large numbers of the larvæ. The most of the dung is dropped in places where the cattle collect after feeding, or at night and could be treated without much trouble.

The Two-Spotted Mite.

(*Tetranychus 2-maculatus, n. sp.*)

Ord. Acarina: Fam. Tetranychidæ.

We first noticed this species in Orono, Me., early in the spring of 1891, upon rose bushes exposed in a window at the Post Office. Since then it has spread to most of the plants in the window excepting geraniums, for which it seems to have an aversion. Mr. White whose rose bushes were infected thought the mites got on while his plant was loaned to a sick lady, but on inquiring we found no other plants were in the sick room at the time and the only possible source of infection was cut plants, which was improbable. In order to learn how general the distribution of this mite was in this region, we visited several houses in Orono, where house plants are kept, aud in the majority of places found the mites doing considerable damage. Rejecting the positive statement of one party that these mites are the same as lice on hens and that her plants were all right until she set them out of doors and some lousy fowls infested them, we are inclined to think that the pest was introduced in Maine upon rose bushes and other plants purchased of a prominent dealer. The parties whose plants are infested in most cases had plants from this house and one party positively affirmed that the roses received were noticed to be infested when unpacked. Though great vigilance ought to be exercised by dealers that the plants they send out are in good health and not infested with injurious insects and fungi, yet they cannot always be held responsible, especially when the parasite is small and readily overlooked. Those who receive infested plants will have to discard them, or fight the pest by aid of known remedies.

Even experience has been no protection against the introduction of this mite for it has found its way into the large green houses of the country, also in the green house at the college in our own State and has been a source of much annoyance.

The mite is so small it is next to impossible to examine green-house stock or house plants carefully enough to prevent its introduction, and the custom of exchanging slips of plants for culture, so common in every neighborhood, aids greatly in its rapid dissemination.

The mite being firmly established in Orono and no doubt in many other places in the State, and having given so much trouble at

various green-houses in the country and apparently never having been studied, described or figured by any of our entomologists; information regarding its life history, structure and control would seem to be of enough importance to warrant a careful study of the pest.

Having spent some time during the past two years investigating the nature of this species, the following preliminary notes upon it are humbly submitted, with the hope that they may aid in recognizing the form and put our florists upon their guard against it. We cannot hope to have been infallable in our observations, but have tried faithfully to record what we have seen.

We desire to acknowledge our indebtedness to Prof. L. H. Bailey of Ithaca, N. Y. for specimens of this mite, and also of the red spider for comparison, for a list of host plants and other data from his experience with it; to the Dingee & Conard Co., West Grove, Pa., for specimens of red spider and notes; to Peter Henderson & Co. for specimens of the mite on *Verbena* and notes; to Prof. Munson and citizens of Orono who from their abundance have supplied us without reluctance with all the specimens used for study.

Correspondence.

After discovering this mite at Orono, Prof. Munson suggested that it was probably the same species that had given so much trouble in the green-houses at Ithaca, N. Y. We wrote Prof. Bailey and sent him a description of the mite. He responded: "Your description seems to match the mighty mite which we have. I do not know its name. Prof. Comstock does not know it." We wrote again for specimens for comparison and a list of food plants and in our letter called the species *Tetranychus 2-maculatus*, n. sp., as we had not been able to find any published description of it. Prof. Bailey responded with specimens upon Pepino, which proved to be the species found at Orono, also he stated: "This is the 'Verbena mite,' I suppose, of Henderson's Practical Floriculture." We responded to Prof. Bailey that the specimens sent were the same as the species found here, but whether they were the same as the *Verbena mite* referred to in Henderson's Practical Floriculture could not be determined by the vague description given in that work, which though it might serve the purposes of practical horticulture, was valueless from an entomologist's standpoint.

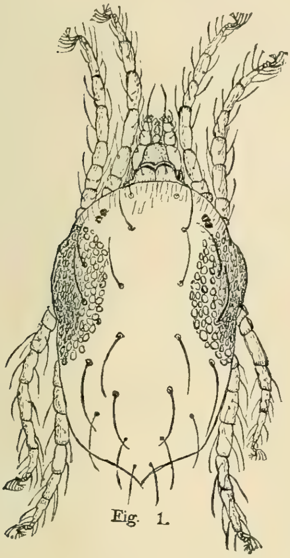


Fig. 1.

Fig. 2.

Fig. 3.

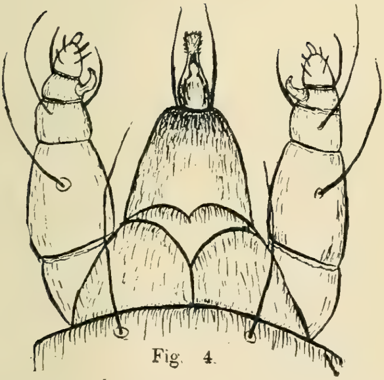


Fig. 4.

F. L. HARVEY, Del.

TWO SPOTTED MITE.

(Tetranychus 2-maculatus, n. sp.)

Fig. 1. Male mite magnified 100 times. Fig. 2, Female (probably) magnified 100 times. Fig. 3. Foot much magnified *(a)* showing location of moveable joint. Fig. 4. Mouth parts and palpi magnified about 250 times.

If you have seen what Henderson calls the "*Verbena mite*" and know it to be the same species as you sent me, that certainly is a clincher. Henderson's figure certainly is nothing like the mite in question. His figure is pointed in front while the mite we are considering is broadly oblong and rounded in front. Henderson's figure is 20 m m. (.8 in.) in length and he says it is magnified four hundred times. This would make the mite only .05 m m. (.002 in.), a *very minute microscopic form*. The mite we are considering is fully .5 m m. or .02 in. and *plainly* visible to the naked eye. Perhaps Henderson made a mistake and his drawing was only forty times magnified. We could believe this if he did not state that the *Verbena mite* "is so small that it cannot be seen by the naked eye." Henderson says it has the power of imbedding itself in the leaf, a habit which *certainly* does not apply to the species in question. Certainly Henderson has made a good many mistakes in his description or the species he examined was a different species. We believe it is best for entomologists to entirely ignore such loose, vague descriptions of insects as they are of no technical importance and only add confusion in defining species.

In the absence of any known technical description of this species, we concluded it would be better to describe it under the name *Tetranychus 2-maculatus*, n. sp., and have something *definite* than to leave the form without a name. Should it subsequently be shown that it has been described then our name drops and no harm is done. We will be most grateful for any evidence that this species has been described or named for we have no ambition to multiply synonyms.

Prof. Bailey responded: "I am aware that neither Henderson's description nor figures are applicable to the mite in question, and yet I think that he meant it, for I have known for some time that he has been troubled with the same species we have. Of course the reference, even if proved to apply to the mite, is of no scientific use, and I only referred you to it that you might perhaps gain a wider knowledge of its hosts and distribution. No doubt Alfred Henderson could send you specimens for determination."

Prof. Bailey kindly introduced us to Mr. Henderson and we requested specimens of the *Verbena mite* which proved to be the *same* species found at Ithaca and Orono.

Parties about Orono having stated *positively* that roses obtained from Dingee & Conard Co., West Grove, Pa., were infested by this mite, and we having seen the mite on rose bushes from that firm at one house and not on *any other* plants, and the mite having

been first noticed at the Post Office in Orono on roses, we wrote Dingee & Conard Co. about the matter and below we give their reply.

West Grove, Pa., Jan. 21, '92.

Francis L. Harvey, Esq.,

Orono, Me.

Dear Sir:—Your kind letter to hand and contents carefully noted. We will gladly give you any information we can to assist you in this important undertaking. The insect or pest you describe which is so seriously affecting window and house plants through your locality, we must say we know nothing of. We have not come in contact with such a pest in any of our houses or on our plants like this, and can assure you it did not originate with us, or we would know something of it. Such pests are more frequently found among soft wooded plants. We have but little of this class of stock in our establishment and consequently are troubled but little with any insect. We are sometimes visited with the *red spider* on our roses, but such is a very rare occurrence, and when thus affected it is not at all a serious matter to get rid of them, syringing them twice a day being a very satisfactory remedy and always effective. We find when plants are kept in a perfectly healthy condition there is little or no danger of the pest or insect of any kind attacking them. The *red spider* can hardly be termed a pest. It is with us but a mild disease caused by too warm and dry an atmosphere. We shall be glad if this information is of any advantage to you and will gladly give you any other information we can.

Very truly yours,

The Dingee & Conard Co.

We wrote again to Dingee & Conard Co. for specimens of what they regarded as the *red spider*, and the species sent was the same as the one found here so far as we could tell from a careful microscopic examination. We also requested Prof. Bailey to send us specimens of the *red spider*. He said they had none in their houses but one of his men procurred some from another source which we were unable to separate from the Cornell green-house specimens only by their being redder in color.

We must confess that we are very much confused by the above data. Henderson, Bailey and Munson, who have had considerable experience with this mite are decided in their opinion that it is entirely different in its habits from the *red spider* and will not

yield to the same treatment. If the specimens sent us by Dingee & Conard Co. and Prof. Bailey's men, were the genuine *red spider*, we are forced to conclude that in this mite we have a species scarcely separable from the *red spider* by its structure but differing very much from it in habit. If called upon to decide from the structure alone we would be compelled to call it a form of the polymorphous species *Tetranychns telarius*, L., or *red spider.*

No importance can be attached to color in this species nor in the *red spider* for in both it is variable with the food plant and also with the age, each molt disclosing a different shade. All we have left upon which to construct this species is the marked physiological differences, noted by Henderson, Bailey and Munson. Can it be possible that it is a case of adaptability—a form of the *red spider* that has changed its mode of living to suit new conditions? Such cases are not uncommon among insects. We leave it an open question for a want of sufficient data. The published descriptions and figures of the *red spider* are so meagre and so lacking in minute detail that it would be very difficult to determine from them whether specimens in hand belonged to that species. Even the published characters of the genus Tetranychus are faulty on account of imperfect microscopical examination.

General Description.

Perfect insect—length of full grown specimens, including palpus, .4 to .6 m m.; breadth, .25 to .3 m m.; thickness .175 to .2 m m. Broadly oval, about two thirds as broad as long. Broadest in the anterior third of the body back of the eyes, where the sides are somewhat swollen. General color when young or free from food, pale orange or greenish yellow, becoming yellowish orange or orange with age. The *majority* of the specimens have a dark spot on each side as shown in Fig 1. due to food contents. These spots first appear, in young specimens which have six legs, as scattered brownish or greenish spherical bodies that look like oil drops. These increase in number with age and are sometimes arranged in three groups. Finally they merge into a single mass as shown in Fig. 1. In older specimens dark patches are found in the anterior and posterior portions of the body, (see Fig. 2), or in full fed specimens the body is entirely dark colored. The shade seems to vary with the color of the food, from the yellow orange and brown to green, dark green or black; those feeding on calla, especially, a deep dark green.

The palpi and legs, especially in older specimens, are tinged with orange. The young are smaller, paler and have only six legs. Body and legs clothed with stout bowed hairs. There are four rows of about five hairs each on the dorsal aspect of the body. Eyes carmine, composed of two facets placed one ahead of the other, and obscurely bilobed. Palpi about one-fourth the length of the body. Eggs spherical, diameter variable, length 75 to about 110 micromillimetres, glassy, scattered and loosely attached to the web. Web delicate, filmy, stretched loosely over the surface of the plant, principally on the under surface of the leaves, though sometimes the upper surface is covered, often stretching across from leaf to leaf, or from the stem to the petioles. They are more plentiful along the principal veins, especially where they join the petiole, also in the angle where the petioles join the leaf, being plainly visible to the naked eye and giving a glassy or silvery reflection from the surface covered. Fibers of the web are from 10 to 20 micromillimetres in diameter but apparently composed of smaller fibrils. The web does not seem to be geometrically constructed as that of the spider. The mites walk freely over the surface or secrete themselves beneath it. The feet are long and the movement of the mite slow and spider-like.

Microscopic Characters.

The body, legs and mouth parts magnified five hundred diameters appear finely corrugated, the ridges and furrows often less than .001 m m. wide. On the under side of the body toward the posterior end is an elevation in which the corrugations are much wider and zig-zag. This probably marks the location of the spinerets and anal opening. The stout hairs clothing the body are in full grown specimens often one-fourth the length of the body, or about .15 m m. The eye facets are about .05 m m. in diameter. The hairs on the legs are about four times as long as the legs are wide where they occur, or sometimes fully .1 m m. long. The legs are composed of seven joints exclusive of the moveable foot portion. The seventh joint is short, a little longer than the three segments of the foot combined and has but little movement with the sixth joint. The foot portion is composed of three joints, the proximal two about equal in size, same length but wider than long; terminal segment curved and ending in a two claws; each fork ending in a brush of about three stiff, pointed, spreading hairs. At the back on the end of the preceeding segment arise four stiff bowed hairs over .02 m m. long ending in hemispherical

swellings which are broadest at the end and flat or slightly rounded. These hairs curve in the same direction as the claw and extend considerable distance beyond it. There is a free joint between the seventh segment of the leg and the foot portion. The two joints and the claw make up the moveable parts. When walking on glass or any smooth surface the mite puts the paw out behind as one would bend the hand backward at the wrist, resting on the end of the seventh joint, the claw and the end of the four stiff hairs, the terminations of which are put squarely down upon the surface. These hairs with enlarged ends may be used for spinning as suggested by Murray, but one cannot watch the movements of this mite without believing they are adapted for locomotion.

According to Murray, the stiff hairs on the feet of *Tetranychus telareus* (the *red spider*) are attached to the claws, and he has so represented them in a cut (Economic Entomology, p. 97). In this species they are appendages of the small joint of the foot next to the claws. Also he says these hairs have globular terminations and so figures them. In our specimens the hairs end in trumpet-mouth like terminations, disc-like at the ends and are put flat on the surface in locomotion. Prof. Riley in *T. 6—maculatus*, (U. S. Agrl. Report, 1889, p. 111), represents the hairs as originating from the back of the claws and as hooked at the ends. The mouth-parts of the *red spider* as shown by Murray, and those of *T. 6 maculatus*, Riley, differ from those of our species.

According to the characters laid down for the genus *Tetranychus* by Murray, there should be only seven joints in the legs. We are at a loss to know just what was included by him in the terminal or tarsal joint. There are seven segments in the leg above the moveable joint in the foot region spoken of above. If the three moveable elements below this joint constitute a distinct segment, then there are *eight* joints to the leg. If the fixed short segment above the moveable joint is concluded in the terminal segment, then there are only *seven* joints to the leg. The location of the joint is shown in Fig. 3, a. Extending from the front of the carapace are the mouth parts, made up of the palpi, rostrum or beak, proboscis and mandibles. The *palpi* (see Fig. 4) are seven jointed. The terminal joint is short, about .008 m. m., with parallel sides and an obtuse rounded end, twice as long as broad. Second joint is broadly conical, somewhat broader at the base than long, length about .015 m. m. at top and .025 m. m. at base, bearing on

the inner face about four bristles, see Fig. 4. The third joint is not more than half as long as broad (about .015 m. m. by .03 m. m.) bearing on the inner side a claw about .02 m. m. long, curved toward the face of joint two, which bears the bristles. There is a free motion between segments two and three, and joints one and two are moveable and opposed to the claw on joint three, making nipping jaws. The structure of the end of the palpus of this species has a striking resemblance to that of *T. 6—maculatus*, Riley figured in U. S. Agrl. Report, 1889, pl. II., though the third short joint bearing a claw seems to be absent, or not shown in his drawing. The *rostrum* or *beak* is composed of three segments, (see Fig. 4) the basal one composed of two parts, broad at the base and rounded in front, and at the carapace reaching beyond and covering the base of the palpi. The second joint is short and emarginate in front, terminal segment tongue shaped, obtuse and emarginate in front. Originating beneath the rostrum and extending forward beneath the palpi are two stout hairs. The basal portion of the proboscis is covered by the beak of the carapace. The visible portion is composed of three joints. The basal is broadest and oblong; the terminal one slender, rounded in front and bearing at the edge two short spines and near the end numerous slender spines. The details of the mandibles we could not make out clearly but think they are rounded and plain on the outer margin, bearing at the end a lobe which projects beyond the end of the proboscis.

Greenish black spots are usually found on the leaves of plants affected by this mite. Probably this is the reason why Henderson called the disease by the inappropriate name "Black Rust." It is commonly believed that these dark spots are formed from juices of the plants that have exuded from punctures made by the mites and have dried. A careful microscopic examination proved them to be small usually globular masses from .1 m m. to .175 m m. in diameter and composed of spherical elements from .025 to .035 m m. in diameter. These spherules are clear with granular contents, or greenish with a darker centre. A careful comparison of them with the contents of the body of the mites proved that they were excreta. These yellowish, or black balls are often found attached to the fibres of the web in *mid air* between the points of attachment of the web where it stretches across from leaf to leaf or from stem to leaf. This could not possibly occur if they were exudations from punctures. The web running over the surface and dotted here and there with these yellow and black excreta reminds one of aminute erysiphe in different stages of development.

Host Plants.

From the table of host plants given below, it will be seen that this mite is a general feeder, attacking a wide range of both glabrous and hirsute plants belonging to a wide range of families. This list is no doubt far from complete, as no great pains has been taken to make it exhaustive. Should this mite prove capable of living out of doors it would become a double terror to horticulturists. It at present is found out of doors only in rare instances, and there is no evidence that it is as Henderson suggests, common in gardens, or the same as that which produces roughness to particular parts of cherry, plum and peach trees. Our experience does not warrant the belief that it attacks *especially* plants of lessened vitality. These mites, like plant lice, live by sucking the juice of plants, and are pretty good judges of proper feeding grounds. They are not likely to turn aside from a healthy juicy plant to one of the same species that is sickly and lacking in juices. They are small and would escape observation until a sickly condition was produced in the host plant and attention directed to it. We believe that instead of especially attacking sickly plants they are the cause of lessened vitality. The list of host plants given below shows that the mite has no special preference for pubescent plants, in fact, some of the worst cases of attack we have seen were upon glabrous species. Munson and Harvey are authority for the occurrence of the mite at the Maine State College green-houses and at private houses in Orono and vicinity; Prof. L. H. Bailey for the occurrence of the mite in the green-houses at Cornell College, Ithaca, N. Y.; Henderson for its occurrence in their green-houses, New York City; Dingee & Conard Co. for its occurrence at West Grove, Pa.

Host Plants.

Order.	Common Name.	Techcical Name.	Authority.	Remarks.
Ranunculaceæ.	Jackman's Clematis.	Clematis Jackmanni.	Munson, Harvey.	College green-houses only.
Resedaceæ.	Mignonette.	Reseda odorata.	Munson.	" " " "
Caryophyllaceæ.	Pink.	Dianthus caryophyllus.	Munson.	" " " "
Malvaceæ.		Malope grandiflora.	Bailey.	
"	Indian Mallow.	Abutilon species.	Bailey.	
Geraniaceæ.	Stork's Bill.	Pelargonium species.	Henderson.	Plants of this family have not been attacked at the College nor in Orono.
"	Canary Bird.	Tropæolium peregrinum.	Munson.	
Leguminosæ.	Beans.		Bailey, Munson, Harvey.	At Orono beans out of doors badly affected.
Rosaceæ.	Ordinary Roses.		Havey, Durgee & Conard Co.	
"	Polyantha roses.		Bailey.	
"	Apricot.		Bailey.	Growing out of doors, near green-house.
Lythraceæ.	Cuphea.	Cuphea Llavæ.	Henderson.	
Onagraceæ.	Godelia.	Œnothera species.	Bailey.	
"	Ladies' Eardrop.	Fuchsia species.	Harvey.	Plants in Orono badly infested.
Passifloraceæ.	Gronadella.	Passiflora edulus.	Bailey.	
Cucurbitaceæ.	Cucumbers.	Cucumis sativus.	Munson, Bailey, Harvey.	
"	Musk Melon.	" Melo.	Munson.	College grounds.
Rubiaceæ.		Manettia species.	Henderson.	
"		Bouvardia species.	Henderson.	
Compositæ.	Feverfew.	Leucanthemum Parthenium.	Harvey.	Plants in Orono.
"		Chrysanthemum	Harvey, Henderson.	
Scrophulariaceæ.	Monkey-flower.	Mimulus tigricoides.	Munson.	
"	Musk Plant.	Mimulus Moschatus.	Munson.	
"	Slipper Flower.	Calceolaria species.	Henderson.	
Acanthaceæ.	Thumbergia.	Thumbergia alata.	Bailey.	
Verbenaceæ.	Verbena.	Verbena species	Henderson, Bailey, Harvey.	
		Lantana species.	Henderson.	
Labiatæ.	Sage.	Salvia splendens.	Munson.	
Borraginaceæ.	Heliotrope.	Heliotropum sp.	Henderson.	
Convolvulaceæ.	Cypress-vine.	Quamoclet vulgaris.	Munson.	
"	Moon-flower.	Ipomea noctophylon.	Munson.	
"	Morning Glory.	Pharbitis species.	Bailey.	
Solonaceæ.	Tomato.	Lycopersicum esculentum.	Munson, Bailey, Harvey,	
"	Pepino.	Solanum muricatum.	Bailey, Munson.	
"	Egg Plant.	Solanum melongena.	Bailey, Munson.	
"	Pepper.	Capsicum annuum.	Munson.	
"		Petunia species.	Harvey, Henderson.	
"	Wedding Bell.	Brugmansia arborea.	Harvey.	Very badly infested.
Euphorbiaceæ.	Castor Oil Plant.	Ricinus communis.	Harvey.	Badly infested.
	Hop.	Humulus lupulus.	Munson	Out of doors.
Araceæ.	Calla.	Calla species.	Harvey.	
Smilaceæ.	Boston Smilax.	Myrsiphyllum asparagoides.	Bailey.	Very bad.
Liliaceæ.	Easter Lily.	Lilium Harrisii.	Harvey.	

Remedies.

The experience of Bailey, Henderson and Munson would lead one to conclude that there is no remedy at present known that is entirely effective.

Henderson writes us that one of the best remedies is Fir Tree Oil, and another very good one is Cole's Insect Destroyer but the cost of the latter almost prohibits its being used in large quantities. Prof. Bailey has had considerable experience with Fir Tree Oil but does not find it entirely satisfactory, though of considerable value.

Prof. Munson says he has used an alcoholic tincture of Pyrethrum and finds it quite satisfactory. There is a general belief that the red spider is readily destroyed by a copious use of water and will not flourish in a moist atmosphere. The impression of those who have had most experience with this mite, is that it may be very bad in a moist atmosphere. Prof. Munson relates one instance of a cucumber house where the plants were badly infested though the atmosphere was kept quite moist. We believe, however, that spraying the plants frequently with water, would help hold them in check by reducing the temperature. They seem to enjoy a high temperature.

Henderson believes an ounce of preventive is better than a pound of cure and if the plants are kept in good health they will resist the disease. He has frequently noticed that where plants become pot-bound it would make its appearance while others potted at the same time and shifted as the occasion required would be perfectly free from it, thus showing that the disease is altogether the result of imperfect conditions of growth. We have commented upon this elsewhere under the head of host plants.

Fir Tree Oil can be obtained from August Rölker & Sons, 136 W. 24th St., N. Y., at a cost of $3.25 per gallon, in five gallon lots, less ten per cent. for cash with order. It should be diluted about one hundred times with water and applied with a syringe or atomizer.

Alcoholic Tincture of Pyrethrum—Digest one part by weight of Pyrethrum (Dalmation Insect Powder) in four parts of commercial alcohol and apply the undiluted tincture to the foliage with an atomizer.

Cole's Insect Destroyer—Mr. Henderson says: "Is sold in half pint cans, price 50 cents. It is already for applying with an atomizer, such as is used for perfumery. Being very powerful a little is sufficient. For house plants we know of no better insecticide."

Cut Worms.

We publish the following correspondence not to criticise Mr. Fowler but to call attention to the loose way in which names are applied to insects and the importance of being certain about the names of insects doing injury before applying remedial measures. We were glad to receive Mr. Fowler's letter for it offered us the opportunity of explaining the restricted use of the term cut-worm by entomologists and that it is not used in the brood sense that includes any kind of worm found feeding upon the roots of farm crops. We will always be pleased to answer questions or explain differences of opinion.

Correspondence.

Searsmont, Me., Sept. 9, '92.

Mr. F. L. Harvey:

Dear Sir:—Part V of Ag. Rept. is at hand and in reading about cut-worms I think my experience may help some one. Cut-worms used to trouble my beets and corn. I noticed when green manure was used in the spring and left uncovered for any length of time—say half a day—a yellow fly such as one sees around manure piles used to fly around and on the manure in the drills, and produce an abundant crop of dark gray or brown or nearly black cut-worms. When manure was hauled from *dark* barn cellar and *immediately covered* found no cut-worms. So by keeping

manure in cellar until wanted for use and keeping cellar dark so no flies would stay there and covering manure immediately I am clear of the pest. Whoever uses barn-yard manure, or manure that is stacked will find plenty of them. For proof examine droppings of cattle in pasture and around buildings and enough of these pests will be found at some stage in the manure. Hoping this may help some as a suggestion I send it.

Very truly,

MOSES A. FOWLER.

The following is our answer somewhat changed and extended for publication :

ORONO, ME., Sept. 23, '92.

MR. MOSES A. FOWLER :

DEAR SIR :—You and I have different ideas about cut-worms. According to my understanding the term cut-worm is *restricted* by entomologists to the larval or caterpillar stage of Hawk Moths such as I have figured in my Report, Figs. 4, 6 and 7 and is not used in the broad sense suggested by you, which would include all worms that eat or cut the roots or other parts of farm crops.

The yellow insects to which you refer belong to the *Order Dieptera* or *two-winged flies*, related to the house-fly and in their worm stage should be called *maggots*. Our root crops are often affected by maggots, as the maggot of the Radish Fly and that of the Onion Fly, but these do not cut off the plants like cut-worms but bore into the roots. The moths of cut-worms lay their eggs near the roots on grass in meadows and pastures and *not* in manure piles. The white *grubs* found in manure are the larvæ or worm stage of beetles (Coleoptera) like the May Beetle and related species. Though the housing of manure is to be recommended to prevent leaching and no doubt if properly protected would be less infested with manure loving larvæ, but cut-worms do not seek such a nidus for their eggs.

Your crops were probably affected by the maggot of some fly, or more probably the grub of some beetle, or possibly by genuine cut-worms that had crawled from adjoining meadow or pasture lands. It may have been the grub of the *Three-toothed Aphonus*

mentioned in my Report, 1891, p. 199, as cutting corn. The sources of insect pests are so many, and the species that feed upon our farm crops so numerous, it is important that each case of injury be carefully examined.

If you will send me in a small box the worms you call cut-worms I will take pleasure in examining them and tell you whether they are correctly named.

Very truly yours,

F. L. HARVEY,

Entomologist for Station.

REPORT OF METEOROLOGIST.

PRESIDENT FERNALD, METEOROLOGIST TO THE STATION.

MAINE EXPERIMENT STATION.

Lat. 44°, 54′, 2″, N. Long. 68°, 40′, 11″, W.

In presenting my fourth annual report as Meteorologist to the Maine Experiment Station, I desire to state definitely as in former reports, that the object sought "is not so much the observing and reporting of general atmospheric phenomena as the careful study of the special meteorological conditions which are more or less intimately connected with practical agriculture."

In order to secure trustworthy results, it is necessary that observations directed toward a solution of any problem in Meteorology be continued through a series of years. Accordingly, in presenting my first report, a plan of summarizing observations and deducing conclusions was adopted, which should be suited to the presenting of like data covering any number of years.

The present report is made in accordance with the prearranged plan and includes in addition to the results of the three preceding years those obtained from about eleven thousand observations taken during the year 1892.

The deductions, therefore, of this report are based upon more than forty thousand independent observations.

The instruments have remained unchanged in position during the four years for which this report is made, and the greater part of the observations have been taken by one observer.

In presenting the arrangement of instruments and other necessary descriptive or explanatory data, I draw freely from my report of last year, simply adapting its statements so far as needful to the more extended period of time.

The most of the instruments employed were manufactured by H. J. Green, of Brooklyn, N. Y. Mr. Robert H. Fernald of

Orono, has been observer during the four years that this work has been carried on. In this report the results of observations made during the years 1889, 1890, 1891 and 1892, are combined.

The several problems considered appear in definite order, in the following pages. The first to which attention has been given, is a determination of the percentage of moisture in forest as compared with that in open field.

The arrangement of instruments for this investigation is herewith submitted.

Hygrometer No. 1 is placed in a wooden stand constructed for thermometrical instruments and located in the open field remote from buildings. Hygrometer No. 2 also is enclosed in a wooden box, perforated to allow a free circulation of air, and located also in the open field. Hygrometer No. 3 is also enclosed in a perforated box attached to a tree in a moderately dense forest. Hygrometer No. 4 is placed in a similar box attached to a tree in a portion of the forest a little more open than that in which No. 3 is located, but near which is a running brook except during the driest part of the summer.

Each hygrometer is about four feet above the surface of the ground. Readings are taken three times daily, at 7 A. M., at 1 P. M., and at 7 P. M., local time.

Observations were commenced April 5, 1889 and they have been continued through the growing seasons of 1889, 1890, 1891 and 1892.

The monthly averages are given in the following tables on the scale of 100.

Percentages of Moisture.

Hygrometer No. 1.—In Open Field.

	1889.			1890.			1891.			1892.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April	81	53	66	74	50	58	85	61	67	74	47	57	64
May	84	60	71	81	62	74	82	57	67	78	63	67	71
June	88	67	81	83	72	75	83	62	71	86	69	74	76
July	85	65	75	85	74	79	87	61	72	84	57	69	74
August	95	70	80	90	63	77	89	67	83	92	70	8[illegible]	80
September	93	68	83	93	76	85	92	67	84	97	61	81	82
October	94	66	79	90	62	79	90	63	80	86	64	76	77
Mean results	89	64	76	85	66	75	87	63	75	85	62	72	75

Hygrometer No. 2.—In Open Field.

	1889.			1890.			1891.			1892.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April	78	52	65	70	46	56	84	62	70	74	50	63	64
May	80	53	68	78	61	74	80	55	68	78	63	70	69
June	84	66	74	78	68	75	82	62	73	84	67	73	74
July	79	60	69	80	63	71	86	62	75	82	55	67	71
August	87	67	75	88	62	73	87	65	80	90	68	81	77
September	91	60	81	91	67	83	91	67	85	92	60	81	79
October	93	66	81	91	62	79	91	65	82	83	64	77	78
Mean results	85	61	72	82	61	73	86	63	76	83	61	73	73

HYGROMETER NO. 3.—IN FOREST.

	1889.			1890.			1891.			1892.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April	81	62	60	78	61	69	90	73	77	83	63	71	72
May	83	63	73	87	74	81	86	68	75	86	71	76	77
June	89	80	84	87	77	82	88	81	84	91	78	82	73
July	94	86	91	93	85	83	92	80	85	92	74	81	86
August	91	89	93	94	80	84	95	81	88	96	85	89	89
September	96	88	92	96	87	92	95	81	92	96	77	88	88
October	96	90	90	96	86	90	92	77	86	90	80	85	88
Mean results	90	80	85	90	79	83	91	77	84	91	75	82	82

HYGROMETER NO. 4.—IN FOREST.

	1889.			1890.			1891.			1892.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April	83	65	77	79	60	71	91	74	82	84	65	75	75
May	89	66	80	88	73	84	87	69	78	87	74	77	79
June	92	81	86	89	77	84	90	74	82	92	79	84	84
July	93	79	87	91	79	85	93	79	86	94	72	80	85
August	95	86	91	91	78	85	96	78	90	97	86	90	89
September	96	83	90	97	86	92	96	79	92	95	76	87	88
October	96	80	90	94	80	89	92	76	87	91	79	86	87
Mean results	92	77	86	90	76	84	92	75	85	91	76	81	84

Percentages of Moisture.

RESULTS FOR 1889, 1890, 1891 AND 1892, COMBINED.

	7 A. M.	1 P. M.	7 P. M.	Mean
Hygrometer No. 1, in open field.	86	64	75	75
" " 2, " " "	84	62	73	73
" " 3, in forest,	90	78	84	84
" " 4, " "	91	76	84	84

Regarding the mean results from hygrometers Nos. 1 and 2 as indicating percentages for the open field, we have the following summary of results:

	7 A. M.	1 P. M.	7 P. M.	Mean
Percentages of moisture, open field,	85	63	74	74

Regarding the mean results from hygrometers Nos. 3 and 4 as indicating percentages for forests only moderately dense, we have the following summary results:

	7 A. M.	1 P. M.	7 P. M.	Mean
Percentages of moisture, forest,	91	77	84	84

Comparing results, open field and forest, we have excess of moisture in forest above that in open field expressed in percentages.

7 A. M.	1 P. M.	7 P. M.	Mean
6	14	10	10

It thus appears from observations covering the period of growth of four years, that the excess of moisture in forest above that of open field in the morning, amounts to but 6 per cent., while in the middle of the day it rises to 14 per cent., and at night-fall drops down to 10 per cent., and that the mean excess for the day is 10 per cent. In a very dense forest the percentage of excess would undoubtedly rise much higher. The presence of patches of forest in any region exerts a marked influence on the hygroscopic conditions of the atmosphere, and this condition, in turn, is an important factor in the growth of vegetation.

Soil Temperatures.

In this investigation a knowledge of the temperature of the soil at different depths, during the growing season, is sought, and ultimately the law which represents the rate of change of temperature at different depths.

The periods covered by the experiment are from May 1 to Nov. 1, 1889, from April 1 to Nov. 1, 1890, 1891 and 1892, with thermometers placed in the soil to the depths of 1, 3, 6, 9, 12, 24 and 36 inches.

The thermometers have been allowed to remain in place during the winters intervening between the periods of observation.

Their location is in the open field, near hygrometer No. 2, in the tract of land assigned to the Station for experimental purposes and devoted to farm experiments. The character of the soil is regarded, therefore, as representative of that on which the field experiments by the Station are carried on.

A summary of results for the four seasons by monthly averages is given in the annexed tables.

SOIL THERMOMETERS—1889.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
May	51.77	62.92	59.20	51.50	60.33	59.70	52.92	55.21	57.04	53.49	53.31	55.44	52.46	52.15	53.21	48.84	49.06	49.01	46.28	46.42	46.48
June	61.94	71.54	67.56	61.38	69.62	67.76	61.85	68.43	65.35	62.07	62.27	63.51	61.26	61.10	61.79	57.23	57.43	57.41	54.36	54.54	54.52
July	63.41	72.10	68.89	63.10	70.86	69.54	64.25	66.51	67.48	64.93	65.15	66.27	64.30	64.02	64.29	60.99	61.14	61.03	58.50	58.62	58.57
August	61.18	69.59	66.90	61.75	68.91	68.01	62.90	64.83	66.01	59.82	63.88	65.01	63.31	63.10	63.31	60.96	61.10	60.97	59.16	59.31	59.23
September	57.11	61.56	61.45	57.74	63.01	62.89	59.47	60.25	61.29	60.29	60.20	60.93	60.30	60.21	60.04	59.42	59.51	59.36	58.40	58.51	58.37
October	42.80	43.59	45.50	43.80	47.31	46.72	46.06	46.48	47.12	47.21	46.97	47.32	48.17	47.83	47.85	50.63	50.65	50.54	51.66	51.66	51.61
Mean	56.37	63.55	61.58	56.54	63.34	62.44	57.91	60.28	60.71	57.97	58.63	59.75	58.30	58.06	58.41	56.34	56.48	56.39	54.84	54.73	54.79
Mean temperature for six months	60.50°			60.77°			59.63°			58.78°			58.26°			56.40°			54.79°		

SOIL THERMOMETERS—1890.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
April	33.74	40.35	36.89	36.53	38.12	37.11	34.32	34.55	35.13	33.56	34.09	34.29	34.57	34.55	34.75	34.81	34.83	34.95	35.31	35.39	35.37
May	50.38	54.80	51.53	47.63	54.67	53.40	49.40	50.26	51.49	49.29	49.27	49.72	48.80	48.68	48.82	45.72	45.55	45.84	43.27	43.72	43.77
June............	56.06	60.05	59.68	55.91	60.44	60.07	56.11	56.78	57.55	55.85	55.95	56.32	55.99	55.95	55.82	53.52	53.18	53.27	50.85	50.94	50.96
July	62.82	64.69	64.03	62.66	66.93	66.81	65.91	64.11	64.87	62.85	62.95	63.88	62.70	62.60	62 78	58.77	58.84	58.77	56.25	56.28	56.34
August............	61.80	68.20	67.28	62.15	67.60	67.41	63.69	65.08	66.26	63.91	64.16	64.83	63.87	63.84	63.91	61.72	62.09	61.34	59.43	59.40	59.39
September	56.51	59.83	59.43	57.44	58.93	59.62	58.21	58.56	59.34	58.36	58.30	58.59	58.73	58.58	58.56	58.15	58.43	58.37	57.73	58.05	57.65
October	45.37	47.17	46.67	45 77	47.16	46.76	47.09	47.10	47.23	47.40	47.32	47.66	48.81	48.72	48.59	51.08	50.97	50.86	52.07	52.04	52.00
Mean............	52.38	56.44	55.07	52.58	56.29	55.88	53.54	53.78	54.55	53.03	53.15	53.61	53.35	53.27	53.32	51.97	51.99	51.98	50.70	50.83	50.78
Mean temperature for seven months,	° 54.63			° 54.92			° 53.96			° 53.26			° 53.31			° 51.96			° 50.77		

SOIL THERMOMETERS—1891.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
April	37.70	42.48	42.34	37.69	42.32	42.41	39.03	39.81	41.40	37.64	37.68	39.93	38.80	38.69	38.58	36.87	36.96	37.01	37.46	37.53	37.53
May	46.54	54.03	52.93	54.31	53.73	52.87	47.49	49.27	51.24	47.83	48.22	49.36	47.64	47.63	47.90	45.00	45.14	45.20	43.78	43.49	43.50
June	59.18	65.42	64.53	59.10	64 80	64.21	59.43	60.40	61.73	59.23	58.96	59.67	58.79	58.37	58.60	54.00	54.12	54.11	51.25	51.35	51.37
July	62.70	68.59	67.44	62.78	67.56	67.10	63.08	64.23	65.18	63.17	63.18	62.85	62.39	62 14	62.44	58.16	58.25	58.26	55.75	55.82	55.82
August	62.45	69.07	67.46	62.59	68.03	67.45	63.98	64.97	66.62	63.93	63.99	64.99	63.80	63.59	63.91	60.72	60.83	60.76	58.66	58.75	58.37
September	58.82	62.88	62.41	59.00	62.85	62.55	60.43	60.99	62.00	60.57	60.48	61.21	60.77	60.60	60.73	59.67	59.70	59.65	58.53	58.61	58.36
October	46.03	48.78	47.94	46.20	48.86	48.22	48.20	48.54	48.81	48.78	48.57	49.17	50.02	49.86	49.77	52.74	52.67	52.53	53.61	53.58	53.50
Mean	53.35	58.75	57.86	54.52	58.31	57.83	54.52	55.46	56.71	54.45	54.44	55.34	54.60	54.41	54.56	52.45	52.52	52.50	51.29	51.30	51.49
Mean temperature for seven months,	° 56.65			° 56.89			° 55.56			° 54.74			° 54.52			° 52.49			° 51.36		

SOIL THEMOMETERS—1892.

	1 inches.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
April	38.07	42.65	42.86	38 39	41.17	42.16	39.46	39.85	41.02	38.66	38.93	40.19	39.15	39.03	39.38	37.72	37.85	37.87	37.25	37.30	37.29
May.....	46.35	50.92	51.12	46.88	50.31	51.16	47 33	48.32	49.67	47.40	47.53	48 22	46.92	46.88	47.16	44.44	44.76	44.65	42.97	43.16	43.20
June	58.10	63.02	63.08	58.46	62 89	62.86	58.45	59.50	60.44	58.86	58.59	59.89	58.67	58.64	58.79	54.15	54.19	54.14	51.29	51.41	51.44
July..	63.48	68.29	67.67	63.61	68.18	67.85	63.74	64.28	65.13	63.58	63.47	64.57	63.66	63.36	63.81	59.15	59.24	59.25	56.47	56.54	56.57
August	63.39	68.06	67.87	63.42	69.56	67.67	64.29	65.35	66.04	64.21	64.42	65.34	64.45	64.30	64.62	61.89	61.96	61.85	59.93	60.00	59 99
September	55.84	59.79	59.51	56.17	59.91	59.59	57.54	58.26	58.81	57.78	57.65	58.38	58 37	58.09	58.27	58.14	58.25	58.18	57.99	57.65	57.61
October..	44.61	46.64	46.85	44.60	46.56	46.82	46 87	46.82	47.29	46.80	46.62	46.34	47.97	47.83	47.85	50.82	50.80	50.76	51.93	51.88	51.87
Mean............	52.83	57.05	56.99	53.08	56.94	56.87	54.24	54.63	55.49	53.90	53.89	54.70	54 17	54.02	54.27	52.33	52.44	52.39	51.12	51.13	51.14
Mean temperature for seven months,		° 55.62			° 55.63			° 54.79			° 54.16			° 54.15			° 52.39			° 51.13	

In order that comparisons may be made between soil temperatures at different depths and the air temperatures during the same months and in the same locality, the following tables are added:

THERMOMETER IN THE OPEN AIR.

(Locality the same as that of the soil thermometers.)

1889.

	7 A. M. °	1 P. M. °	7 P. M. °	Mean. °
May,	52.95	68.30	59.47	60.24
June,	63.36	74.27	68.07	68.57
July,	65.12	75.75	70.86	70.58
August,	59.97	74.20	66.81	66.99
September,	54.39	70.86	61.55	62.27
October,	37.41	52.80	44.05	44.75
Mean,	55.53	69.36	61.80	62.23

1890.

	7 A. M. °	1 P. M. °	7 P. M. °	Mean. °
April,	35.76	49.02	42.55	42.44
May,	49.16	60.60	53.58	54.45
June,	57.95	67.64	62.76	62.78
July,	67.10	76.19	71.85	71.71
August,	61.50	73.78	68.84	68.04
September,	52.04	66.16	58.52	58.91
October,	37.70	53.19	45.63	45.51
Mean,	51.60	63.80	57.68	57.69

1891.

	7 A. M. °	1 P. M. °	7 P. M. °	Mean. °
April,	36.33	48.26	43.64	42.74
May,	47.07	61.75	53.30	54.04
June,	58.28	72.42	65.38	65.36
July,	64.08	76.05	68.81	69.65
August,	62.07	74.94	67.47	68.16
September,	56.13	69.72	61.80	62.55
October,	38.11	54.02	45.56	45.90
Mean,	51.72	65.31	57.99	57.34

1892.

	7 A. M.	1 P. M.	7 P. M.	Mean.
	°	°	°	°
April,	37.29	51.93	45.10	44.77
May,	47.00	58.95	54.19	53.38
June,	58.74	70.65	67.29	65.56
July,	65.58	78.54	71.92	72.11
August,	61.16	74.15	67.46	67.50
September,	53.33	68.19	56.52	59.68
October,	40.98	51.65	45.13	45.94
Mean,	52.05	64.87	57.38	58.43

Tables Showing Changes of Temperature in the Soil for Increased Depths.

1889.

Depth of Thermometer.	Mean temperature for 6 mos., May to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	60.50		
3 inches	60.77	+0.27	+0.13
6 inches	59.63	—1.14	—0.38
9 inches	58.78	—0.85	—0.28
12 inches	58.26	—0.52	—0.17
24 inches	56.40	—1.86	—0.15
36 inches	54.79	—1.61	—0.13

1890.

Depth of Thermometer.	Mean temperature for 7 mos., April to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	54.63		
3 inches	54.92	+0.29	+0.14
6 inches	53.96	—0.96	—0.32
9 inches	53.26	—0.70	—0.23
12 incnes	53.31	+0.05	+0.02
24 inches	51.96	—1.35	—0.11
36 inches	50.77	—1.19	—0.10

1891.

Depth of Thermometer.	Mean temperature for 7 mos., April to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	56.65	+0.24	+0.12
3 inches	56.89	—1.33	—0.44
6 inches	55.56	—0.82	—0.27
9 inches	54.74	—0.22	—0.07
12 inches	54.52	—2.03	—0.17
24 inches	52.49	—1.13	—0.09
36 inches	51.36		

1892.

Depth of Thermometer.	Mean temperature for 7 mos., April to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	55.62	+0.01	+0.003
3 inches	55.63	—0.84	—0.28
6 inches	54.79	—0.63	—0.21
9 inches	54.16	—0.01	—0.003
12 inches	54.15	—1.76	—0.14
24 inches	52.39	—1.26	—0.10
36 inches	51.13		

An examination of the tables shows that the soil responds readily to the daily heat of the sun to the depth of three inches, less readily to the depth of six inches, in a moderate degree only to the depth of nine inches, and very slightly below twelve inches. To the depth of three inches the range between the morning and the midday observations has been as high as fifteen degrees. The mean daily range at the depth of 1 inch during the period of observations was 5°.22; at the depth of three inches, 4°.54; at the depth 6 inches, 1°.81; at the depth of 9 inches, 1°.02, and 12 inches very slight.

At the depth of 3 inches, the average temperature of the soil was somewhat higher than at the depth of 1 inch. The surface soil averaged about five degrees warmer than the soil 36 inches below the surface.

The rate of reduction of temperature with depth below the layer three inches from the surface is shown in a general way in the foregoing tables.

This rate is probably in accordance with a simple law which can be expressed by a mathematical formula, variable, undoubtedly, for different soils. However, on examining the "changes in temperature for one inch" in the foregoing tables, it will be noticed

that the rate has been clearly vitiated since 1889 by the record of the nine inch thermometer.

The anomalous action of this instrument is accounted for by the fact, that at the end of the year 1889, the nine inch thermometer first used was broken and a new one was substituted. The contact of the latter with the soil was not the same as that of the former, nor has it been the same as that of the other instruments which have not been disturbed in the four years.

This accident, although vitiating the results of the present investigation, is not without its value, since it clearly indicates the need of maintaining uniform conditions in carrying on a work of the nature and delicacy of that for which soil thermometers are employed.

Comparing soil temperatures with air temperatures during the four seasons, the following mean results appear: At the depth of 1 inch, the temperature of the soil was lower than at that of the air by 2°.32; at the depth of 3 inches, by 2°.12; 6 inches, by 3°.22; 9 inches, by 3°.94; 12 inches, by 4°.12; 24 inches, by 5°.86, and at the depth of 36 inches, by 7°.16.

Terrestrial Radiation.

The heat radiated from the surface of the earth during the night reduces its temperature several degrees below that of the surrounding atmosphere. The amount of this radiation or the consequent reduction of temperature is approximately shown by comparing the readings of a terrestrial radiation thermometer with those of a minimum thermometer. In obtaining data for the comparison given below, the minimum thermometer was four feet above the ground and the terrestrial radiation thermometer was within six inches of its surface. The results are based on monthly averages from May to October inclusive, 1889, from April to October inclusive, 1890, 1891 and 1892.

Table Showing Loss of Heat by Terrestrial Radiation.

1889.

	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	o	o	o	o	o	o	o
Mean of minimum temperatures......	46.63	53.25	55.08	53.65	49.07	33.91	48.50
Mean of Temp. from Ter. Rad. Ther..	38.48	49.20	50.59	47.66	44.60	28.48	43.17
Loss of heat by radiation............	8.15	4.05	4.49	5.39	4.74	5.43	5.33

1890.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	°	°	°	°	°	°	°	°
Mean of minimum temperatures......	29.17	42.52	48.71	53.61	53.52	45.32	36.05	44.13
Mean of Temp. from Ter. Rad. Ther..	19.95	37.10	42.10	44.55	46.25	38.40	27.14	36.50
Loss of heat by radiation....	8.22	5.42	6.61	9.06	7.27	6.92	9.91	7.63

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	°	°	°	°	°	°	°	°
Mean of minimum temperatures......	30.22	37.67	49.18	53.15	54.07	49 23	34.95	44.07
Mean of Temp. from Ter. Rad. Ther..	24.45	29.09	40.87	43.94	47.40	42 22	25.60	36.23
Loss of heat by radiation...........	5.77	8.58	8.31	9.21	6.67	7.01	9.35	7.84

1892.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	°	°	°	°	°	°	°	°
Mean of minimum temperatures......	30.32	39.08	50.73	54.65	55.77	45.69	34.47	44.39
Mean of Temp. from Ter. Rad. Ther..	22.29	30.64	41.89	45.05	46.38	37.45	28.02	35.96
Loss of heat by radiation............	8.03	8.44	8.84	9.60	9.39	8.24	6.45	8.43

On cloudy nights the difference in the reading of the two thermometers is small, and on exceptionally clear (dry) nights it is a maximum. The greatest range observed was 19.5° Occasionally, the reading of the radiation thermometer is higher than that of the minimum thermometer, showing that the moist air at such times, resting upon the surface of the ground, serves as a warm blanket, and that the amount of heat then absorbed is greater than that radiated. The table above shows that the mean radiation for the four seasons was 7.31°.

Solar Radiation.

The temperature of the atmosphere does not indicate the intensity of the sun's heat, as only a small percentage is absorbed as the rays are transmitted through the air. The maximum thermometer in the shade, therefore, does not give the intensity of solar radiation ; neither does exposure of an ordinary thermometer to the direct rays of the sun, in consequence of the cooling effects of draughts of air. In order to avoid the effects of currents of air, the *vacuum solar radiation thermometer* has been devised. "This consists of a blackened bulb radiation thermometer inclosed in a glass tube and globe, from which all air is exhausted. Thus protected from the loss of heat which would ensue if the bulb were exposed, its indications are from 20° to 30° higher than when placed side by side with a similar instrument with the bulb exposed to the passing air." By the use of this instrument the amounts of solar radiation at different places and in different seasons at

the same place are rendered comparable. The relations of solar-intensity, as distinct from temperature of the air to the growth and maturity of crops, are worthy of careful investigation. High solar intensity maintained through the latter part of the growing season has an important bearing upon the complete ripening of vegetables and fruits and likewise upon their keeping qualities. From the wide range of observations undertaken by Experiment Stations with radiation thermometers, important deductions may reasonably be expected. I subjoin tables of results from the maximum thermometer and the thermometer for solar radiation, expressed in monthly averages.

1889.

	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	°	°	°	°	°	°	°
Mean of readings, Sun Ther......	133.02	134.22	139.55	137.56	122.79	105.86	128.83
Mean of maximum temperatures.....	67.85	73.45	75.30	73.72	71.23	52.78	69.05
Excess of solar intensity............	65.17	60.77	64.25	63.84	51.56	53.08	59.78

1890.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean
		°	°	°	°	°	°	°
Mean of readings, Sun Ther..	119.15	119.45	128.81	139.37	138.25	114.94	112.52	124.65
Mean of maximum Temp.....	49.37	61.16	68.01	76.53	74.67	62.32	55.61	64.38
Excess of solar intensity......	69.82	58.29	60.80	62.84	63.58	49 62	56.92	60.27

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	°	°	°	°	°	°	°	°
Mean of readings, Sun Ther..	106.78	119.19	129.44	140.35	129 55	121.65	99.55	120.93
Mean of maximum Temp.....	50.65	62.48	72.17	76.68	75.39	69.84	54.18	65.91
Excess of solar intensity......	56.13	56.71	57.27	63.67	54.16	51.81	45.37	55.02

1892.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	°	°	°	°	°	°	°	°
Mean of readings, Sun Ther..	113.32	112.47	127.11	139.50	128.25	123.82	97.62	120.30
Mean of maximum Temp.....	53.93	62.22	72.87	82.28	75.07	68.74	53.16	66.90
Excess of solar intensity......	59.39	50.25	54.24	57.22	53.18	55.08	44.46	53.40

From the above records it appears that the average excess of solar intensity above that given by the maximum thermometer for the growing periods of 1889, 1890, 1891 and 1892 was 57.12°.

The season of greatest excess in this regard was that of 1890, a season noted for the perfect maturity of fruits and vegetables.

Amount of Sunshine.

The amount of sunshine as an essential factor in crop production is worthy of observation and record. Observations were commenced May 1, 1890, and the table below furnishes the summary for the six months following and for seven months, April to November, 1891, and for seven months, April to November, 1892.

Bright Sunshine in Hours.

1890.

	May.	June	July.	Aug.	Sept.	Oct.	Mean.
Sunshine,	180	186	216	193	126	133	172
Hours per day, mean,	5.8	6.2	7.0	2.6	4.2	3.3	5.6

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
Sunshine,	174	207	217	259	225	234	154	209
Hours per day, mean,	5.8	6.7	7.2	8.4	7.3	7.8	5.0	6.9

1892.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
Sunshine,	228	123	198	294	173	259	149	203
Hours per day, mean,	7.6	4.0	6.6	9.5	5.6	8.6	4.8	6.7

During the period covered by the above table, the average hours of bright sunshine per day were 6.4 or 46 per cent. of the possible amount.

Wind and Rain.

The velocity of the wind has been determined by a Robinson's Anemometer, with electrical recording apparatus, attached to the Experiment Station building, and the amount of rain by means of a guage, signal service pattern, located in the same plat as the soil thermometers.

1889.

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	253.93	10.58	1.36
May,	189.83	7.91	1.61
June,	171.12	7.13	4.86
July,	200.33	8.34	3.27
August,	139.35	5.81	1.69
September	198.06	8.25	2.10
October,	194.31	8.09	3.96
Mean,	192.42	8.02	Total, 18.85

1890.

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	241.83	10.07	1.98
May,	235.14	9.79	10.13
June,	230.40	9.60	3.78
July,	166.28	6.95	3.84
August,	187.03	7.65	5.39
September,	155.50	6.45	4.21
October,	189.01	7.85	3.19
Mean,	200.74	8.34	Total, 32.52

1891.

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	210.55	8.77	3.13
May,	206.25	8.59	2.76
June,	182.71	7.61	3.13
July,	185.44	7.73	3.36
August,	169.58	7.07	4.38
September,	162.07	6.75	3.50
October,	191.92	8.00	2.81
Mean,	186.93	7.79	23.07

1892.

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	244.99	10.21	1.09
May,	262.23	10.93	1.99
June,	197.87	8.24	5.66
July,	199.50	8.31	1.88
August,	168.36	7.02	6.11
September,	185.28	7.72	3.43
October,	199.13	8.26	1.46
Mean,	208.19	8.67	21.62

For the full year 1890, the mean daily velocity of the wind was 211.16 miles and the mean hourly velocity, 8.90 miles; for the full year 1891, the corresponding velocities were respectively 214.82 miles and 8.95 miles; and for the full year 1892, 217.33 miles and 9.05 miles.

The rain-fall in May, 1890, amounting to 10.13 inches was larger than in any other month in twenty-four years.

Conclusion.

The foregoing summarized report, although embodying all the data obtained by four years' observations, conveys but an imperfect idea of the daily requirments and nature of the work in progress.

By way of presenting its varied character more fully, as in former years, I append the complete records for one month, selecting for the current report the month of October 1892.

HYGROMETER NO. 1.—IN OPEN FIELD.

OCTOBER, 1892.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°	°	°	°	°	°	°	°	°	°
1.	52.2	45.2	37	57	50.5	44.5	37	61	44.2	39.4	32	65
2.	41.8	37.0	29	63	49.5	41.2	29	46	43.0	38.6	32	67
3.	29.8	29.0	26	91	46.5	41.0	34	62	43.0	42.5	42	96
4.	46.5	46.2	45	98	51.0	48.7	46	85	48.8	48.1	47	95
5.	34.8	34 8	34.8	100	49.8	44.4	38	65	45.2	42.0	39	77
6.	41.5	38.8	36	79	49.0	42.9	36	59	44.2	40.2	35	70
7.	44.2	41.5	38	80	59.0	52.8	48	66	50.0	48.0	46	87
8.	44.8	44.0	42	90	63.4	58.7	51	55	58.2	54.8	52	81
9.	50.1	50.0	50	99	45.8	44.0	42	87	42.4	40.8	39	87
10.	30.3	30.0	28	97	50.1	42.2	31	50	48.0	41.5	33	56
11.	39.7	38.0	36	86	51.0	42.5	31	47	38.8	35.0	29	69
12.	30.0	28.8	27	87	49.0	42.4	34	56	44.2	38.8	30	60
13.	28.0	28.0	28	100	44.8	43.8	42	92	49.4	48.3	47	92
14.	55.0	52.0	50	82	65.7	58.0	51	55	57.0	51.3	47	68
15.	45.0	43.0	41	85	60.1	51.0	43	52	49.8	45.7	42	73
16.	52.2	51.2	50	94	53.2	53.0	52	99	53.4	52.9	52	97
17.	40.0	37.0	33	76	48.4	41.2	33	53	37.2	35.6	33	86
18.	25.6	25.2	24	95	52.8	44.5	34	50	41.1	39.6	37	88
19.	48.7	48.2	48	97	52.0	51.4	51	96	51.2	50.6	50	96
20.	42.4	41.1	40	90	52.8	44.0	33	48	43.0	38.5	32	66
21.	37.8	34.3	29	70	50.7	40.0	25	35	41.7	36.5	29	60
22.	44.9	39.0	30	58	55.2	43.8	28	37	47.7	41.5	38	59
23.	45.1	42.2	39	79	49.9	47.5	45	84	46.6	43.0	40	75
24.	40.0	37.0	33	76	46.1	40.5	33	60	43.8	39.1	33	65
25.	37.7	36.2	34	87	50.9	44.5	37	60	47.9	42.6	36	64
26.	38.8	38.0	37	94	46.7	43.0	40	74	44.7	43.0	42	87
27.	40.3	40.2	40	99	44.9	43.1	43	94	43.6	41.0	38	80
28.	37.3	36.0	35	89	49.5	43.6	37	62	43.7	40.0	36	72
29.	30.0	29.3	28	91	43.8	39.9	35	71	41.2	40.0	39	90
30.	36.2	35.3	34	92	48.0	40.9	32	52	42.1	38.0	33	68
31.	31 0	30.0	28	90	43.2	38.9	32	68	40.3	36.8	31	72
Means.				86				64				76
Mean for month.								75				

HYGROMETER NO. 2.—IN OPEN FIELD.

October, 1892.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°	°	°	°	°	°	°	°	°	°
1.	53.2	45.0	35	51	51.0	42.0	30	45	43.2	35.3	21	42
2.	43.1	37.2	28	56	48.8	40.2	28	44	39 5	35.7	30	70
3.	32.5	32.0	30	95	47.3	44.3	41	79	43.0	42.2	41	94
4.	46.9	46.5	46	97	52.1	50.3	49	89	47.8	47.2	47	95
5.	35.7	35.7	35.7	100	50.5	45.0	38	64	45.9	41.7	37	70
6.	42.2	39.1	35	76	49.5	43.5	37	61	44.2	40.3	35	71
7.	45.2	42.3	39	79	60.8	53.3	47	61	50.2	48.1	46	86
8.	48.0	47.1	46	94	68.0	59.1	53	59	52.5	49.7	47	85
9.	50 0	50.0	50	100	46.2	44.2	42	85	39.8	39.0	37	94
10.	30.5	30.3	29	98	50.2	42.5	32	51	47.1	41.0	33	59
11.	40.0	38.5	36	88	52.3	44.5	34	52	38.1	34.8	29	72
12.	33.0	32.0	30	92	49.0	43.0	36	60	41.8	38.0	33	71
13.	28.9	28.8	28	99	45.8	44.3	43	89	49.2	48.2	47	93
14.	55.6	51.8	49	78	67.8	57.9	51	55	56.5	51.8	49	73
15.	47.5	45.8	44	88	64.0	53.8	46	50	50.2	46.0	42	72
16.	52.7	51.2	50	91	53.8	53.0	51	95	54.0	53.2	52	95
17.	40.0	37.0	33	76	49.1	42.5	34	56	35.3	33.9	31	87
18.	27.7	27.0	25	92	54.7	41.6	23	28	40.0	39.2	38	94
19.	49.0	48.5	48	97	52.1	51.5	51	96	51.2	50.4	49	95
20.	43.6	41.2	38	82	52.4	47.7	43	71	41.8	37.3	31	65
21.	39.0	35.2	29	69	49.5	40.7	27	43	40.1	35.8	28	65
22.	44.8	39.8	33	64	55.8	44.6	31	38	47.2	40.8	31	56
23.	45.3	42.3	39	78	49.8	46.7	44	79	45.4	42.9	40	82
24.	39.8	37.0	33	78	46.9	40.8	33	58	43.6	39.0	33	66
25.	38.8	37.3	35	88	51.8	44.8	36	56	47.8	42.1	36	62
26.	39.0	38.5	38	96	47.2	43.4	39	74	44.3	42.8	41	88
27.	41.7	41.3	41	97	46.1	44.	43	87	44.0	41.2	37	79
28.	35.7	34.0	32	84	52.5	46.1	39	61	39.9	37.8	35	83
29.	32.3	31.0	28	87	44.0	40.0	35	70	42.2	40.8	39	89
30.	36.3	35.5	34	93	46.8	41.6	35	64	41.8	38.0	33	71
31.	32.3	31.5	29	92	43.5	38.0	29	58	41.0	37.0	31	68
Means.				83				64				77
Mean for month.								75				

HYGROMETER NO. 3.—IN FOREST.

OCTOBER, 1892.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°	°	°	°	°	°	°	°	°	°
1.	52.2	47.4	42	70	50.5	44.8	38	63	43.2	38.3	31	62
2.	40.1	36.9	33	74	47.7	42.8	37	67	44.0	40.8	37	76
3.	30.2	29.3	27	90	46.2	43.0	40	77	43.4	42.9	42	96
4.	46.8	46.0	44	94	50.0	49.1	48	94	48.7	48.0	48	95
5.	38.5	38.5	38.5	100	48.0	45.7	43	84	46.5	44.5	42	85
6.	41.1	39.2	36	85	47.8	44.3	41	76	45 0	42.4	40	81
7.	45.2	42.8	40	83	57.0	53.6	51	81	50.3	48.8	49	97
8.	46.5	44.6	42	86	62.0	58.5	56	81	58.0	55.0	53	83
9.	50.2	50.2	50.2	100	46.3	45.3	44	93	43.8	42.8	42	92
10.	32.0	31.9	30	99	46.8	43.0	39	74	47.8	44.0	40	74
11.	40.5	37.8	35	78	48.0	44.4	41	75	40.0	37.8	35	82
12.	30.6	29.5	28	89	48.1	44.9	42	78	46.0	43.0	40	79
13.	29.0	27.8	26	87	41.0	40.7	40	98	47.2	47.0	46	99
14.	51.8	51.5	51	98	65.2	60.5	58	66	56.8	53.8	52	83
15.	39.0	37.8	37	90	55.0	52.1	50	83	50.7	48.6	47	86
16.	50 9	50.5	50	98	52.4	52.2	51	99	52.2	52.0	51	99
17.	40.4	38.9	36	88	46.3	43.1	39	77	39.2	38.8	38	97
18.	27.3	27.0	25	96	47.4	44.8	42	81	41.7	40.5	40	90
19.	48.8	48.2	48	96	51.8	50.9	50	95	51.2	50.8	50	98
20.	41.7	40.2	39	88	53.4	47.0	39	62	41.9	39.4	36	81
21.	36.8	35.4	33	88	48.0	44.5	41	76	41.0	37.7	33	74
22.	42.6	40.4	39	83	49.8	44.7	40	67	48.6	43.0	37	62
23.	41.7	40.6	40	91	49.0	46.0	43	80	46.4	43.8	41	81
24.	39.5	37.4	34	82	45.8	41.9	37	73	45.0	41.2	36	73
25.	37.0	35.8	35	89	49.8	45.1	41	69	48.8	44.0	38	68
26.	39.0	37.8	37	90	46.0	44.0	42	85	44.7	43.1	42	88
27.	41.0	40.0	39	92	44.8	44.0	42	94	46.0	45.0	44	93
28.	38.0	36.5	34	87	45.0	42.3	40	80	42.2	40.7	39	88
29.	30.8	29.8	28	90	42.0	40.8	40	90	40.6	39.8	39	94
30.	35.7	35.7	35.7	100	45.0	41.3	37	75	41.5	38.4	35	76
31.	31.3	30.0	26	86	41.3	38.0	33	74	41.0	38.8	38	91
Means.				90				80				85
Mean for month.								85				

HYGROMETER NO. 4.—IN FOREST.

OCTOBER, 1892.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°	°	°	°	°	°	°	°	°	°
1.	52.0	46.3	41	65	50.6	44.2	37	60	42.9	38.0	31	63
2.	40.8	37.0	31	70	47.5	41.0	31	55	43.2	39.8	35	75
3.	30.3	29.5	27	91	46.2	42.9	39	77	43.1	42.6	42	96
4.	46.8	46.5	46	98	49.6	49.0	48	96	49.2	48.8	48	98
5.	36.3	36.3	36.3	100	47.8	45.7	44	85	46.0	44.0	42	85
6.	41.0	39.1	36	85	47.3	43.8	40	76	45.0	43.5	42	89
7.	43.8	42.2	41	87	57.0	53.0	50	77	50.5	48.1	45	84
8.	45.3	44.2	43	91	62.4	59.3	57	83	56.0	54.7	54	92
9.	50.4	50.4	50.4	100	45.4	45.0	44	97	42.5	42.0	41	96
10.	31.7	31.6	30	99	46.4	41.9	36	68	47.2	43.5	40	74
11.	40.0	37.0	33	76	47.4	44.2	41	78	39.5	38.8	38	94
12.	29.9	29.1	27	91	47.5	43.9	41	75	44.0	41.4	38	80
13.	30.0	28.8	27	87	40.5	40.1	39	97	48.0	47.6	47	97
14.	49.5	49.3	49	99	64.0	58.3	55	71	53.4	51.0	48	85
15.	38.8	38.0	37	94	55.8	51.9	49	78	49.2	46.8	44	84
16.	52.0	50.3	49	89	52.6	52.3	52	99	52.4	52.2	51	99
17.	40.1	38.8	35	85	46.4	42.5	37	73	37.5	36.8	36	94
18.	27.3	27.1	25	98	47.5	43.6	40	74	41.4	40.3	39	91
19.	48.5	48.0	47	96	52.0	51.2	50	95	51.2	51.0	50	99
20.	40.2	40.0	39	98	49.6	45.3	41	72	41.5	39.5	36	84
21.	37.2	35.3	33	88	46.4	42.1	36	70	40.6	37.8	34	78
22.	42.8	40.5	38	83	53.1	44.9	36	51	49.0	44.1	38	68
23.	42.5	40.7	39	86	49.3	48.3	47	93	45.6	43.8	42	87
24.	39.4	37.7	35	86	45.7	41.6	37	71	45.0	41.5	37	75
25.	35.0	34.5	33	95	50.0	44.9	40	67	47.4	44.2	41	78
26.	38.8	37.8	36	92	45.5	43.8	43	87	44.3	43.2	42	91
27.	40.6	40.0	40	95	44.5	43.8	43	94	43.3	43.0	42	98
28.	37.0	36.5	36	96	45.8	43.3	41	82	41.0	39.9	39	91
29.	30.7	30.3	29	96	41.8	40.0	38	86	40.8	40.1	40	94
30.	35.7	35.7	35.7	100	44.3	41.0	36	76	41.2	38.8	35	91
31.	31.3	30.5	28	92	41.0	38.0	34	76	40.7	38.0	35	78
Means.				91				79				86
Mean for month.								85				

SOIL THERMOMETERS.—October, 1892.

Day.	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1	53.7	53.0	50.5	54.0	53.5	51.2	54.6	54.0	53.3	54.0	53.8	53.5	54.5	54.5	54.3	55.6	55.6	55.5	56.2	56.0	55.8
2	46.8	48.0	48.0	46.4	48.0	48.0	50.5	49.8	49.8	50.8	50.0	50.0	52.7	51.9	51.6	55.4	55.3	55.0	55.7	55.7	55.5
3	44.0	47.5	47.5	43.5	47.7	47.0	47.9	48.1	48.5	48.4	48.0	48.5	50.5	49.9	50.0	54.6	54.5	54.2	55.4	55.4	55.3
4	48.0	49.4	49.0	48.3	49.4	50.0	49.0	49.5	50.1	48.9	49.0	49.5	50.0	50.2	50.4	53.8	53.7	53.6	54.9	54.9	54.8
5	46.5	48.4	48.5	47.6	48.4	48.5	49.4	49.0	49.3	49.2	48.7	49.0	50.5	50.1	50.0	53.4	53.3	53.2	54.5	54.4	54.4
6	45.8	47.0	47.0	46.4	47.6	47.5	48.4	48.2	48.3	48.2	48.0	48.0	49.8	49.4	49.4	53.0	53.0	52.8	54.0	54.0	53.9
7	45.2	49.4	49.6	45.5	49.0	49.6	47.2	47.9	48.2	47.1	47.4	47.5	48.8	48.6	49.0	52.5	52.5	52.3	53.8	53.7	53.5
8	47.0	53.0	53.3	48.0	52.0	53.0	49.0	50.0	51.4	48.8	49.2	50.5	49.6	49.8	50.5	52.2	52.3	52.2	53.4	53.5	53.4
9	51.5	50.5	50.0	51.5	50.6	50.2	51.6	51.4	51.0	50.3	51.1	51.0	51.5	51.5	51.5	52.4	52.4	52.4	53.3	53.2	53.0
10	44.8	44.9	48.2	45.5	46.5	48.2	48.6	48.0	48.5	48.7	48.6	48.4	50.2	49.4	49.4	52.4	52.5	52.3	53.0	52.5	53.0
11	45.9	45.9	46.2	46.1	46.7	46.4	47.8	47.8	48.0	47.7	48.0	48.0	49.0	49.4	49.8	50.0	51.7	51.8	52.8	52.6	52.8
12	42.2	47.0	45.8	39.4	47.0	45.5	46.0	47.6	46.4	46.2	47.5	46.2	48.0	48.7	47.4	51.5	51.9	51.5	52.5	52.8	52.5
13	40.7	42.6	45.0	41.3	42.8	44.9	44.6	44.3	45.4	45.0	44.3	45.1	45.8	46.2	46.3	51.0	50.8	50.8	52.3	52.2	52.3
14	45.0	49.0	50.0	45.0	48.5	49.7	46.0	46.9	48.7	45.5	46.1	47.8	46.5	46.9	47.7	50.4	50.4	50.4	52.0	51.8	52.0
15	45.0	49.5	49.6	45.0	47.4	49.0	47.5	47.5	48.8	47.5	47.3	48.2	48.4	48.0	48.4	50.4	50.5	50.4	51.5	52.1	51.7
16	48.4	49.5	50.3	48.4	49.5	50.0	48.5	49.2	49.4	48.3	48.5	48.9	49.0	49.0	49.3	50.5	50.5	50.7	51.5	51.5	51.5
17	47.4	47.5	47.0	47.5	47.4	46.9	49.4	48.5	48.6	49.2	48.5	48.5	49.7	49.4	49.7	50.5	50.6	50.8	51.5	51.3	51.5
18	42.2	46.0	46.1	42.7	45.1	46.1	46.2	45.6	46.8	46.5	45.7	46.6	48.0	47.4	47.5	50.6	50.6	50.5	51.5	51.5	51.5
19	46.1	48.0	48.8	46.3	47.9	48.6	46.8	47.5	48.2	46.6	47.0	47.5	47.5	49.6	48.1	50.2	50.1	50.3	51.3	51.3	51.4
20	45.4	47.0	46.0	45.7	45.9	45.9	47.3	46.9	47.3	47.1	46.7	47.1	48.0	47.8	47.8	50.0	50.0	49.9	51.0	51.0	51.0
21	42.2	44.2	43.5	41.4	44.2	43.8	45.4	45.1	45.4	45.4	44.8	45.2	46.9	46.2	46.1	50.1	49.8	49.6	51.0	50.7	50.7
22	42.4	44.8	45.2	42.7	44.4	45.0	44.7	44.5	45.3	44.4	44.3	45.1	45.8	45.6	46.0	49.7	49.5	49.4	50.7	50.7	50.7
23	41.1	44.0	44.3	41.5	43.0	44.3	44.0	44.0	44.7	44.0	43.7	44.2	45.5	45.0	45.3	49.2	49.0	48.9	50.1	50.4	50.4
24	42.4	43.4	44.0	42.7	43.5	44.0	44.3	43.1	44.5	44.0	43.8	44.2	45.4	45.0	45.0	48.8	48.6	48.5	50.2	50.0	50.0
25	42.0	44.0	45.0	42.0	44.2	44.0	44.0	44.0	44.8	44.0	43.6	44.2	45.0	44.9	45.0	48.5	48.5	48.4	49.8	49.8	49.8
26	42.7	44.6	45.0	42.0	44.5	45.0	44.5	44.5	45.0	44.3	44.4	44.5	45.2	45.1	45.4	48.3	48.3	48.3	49.7	49.6	49.8
27	44.0	45.0	46.0	43.0	46.0	46.3	45.0	45.2	44.6	44.8	44.6	45.0	45.7	45.5	45.6	48.7	48.1	48.2	49.5	49.5	49.5
28	43.5	45.5	45.5	42.5	45.7	45.0	45.0	44.9	45.8	45.0	44.5	45.2	45.7	45.5	45.7	48.2	48.2	48.2	49.5	49.3	49.4
39	41.0	44.0	43.6	40.5	43.4	43.5	44.3	43.6	44.2	44.2	43.5	44.0	45.5	45.0	45.5	48.0	47.0	48.2	49.2	49.2	49.3
30	40.4	42.5	42.5	40.5	42.5	42.5	43.0	43.0	43.2	44.2	43.0	43.2	44.6	44.1	44.1	47.9	47.9	47.9	49.0	49.0	49.0
21	39.5	40.8	41.5	39.8	41.0	41.8	42.4	41.9	42.4	42.4	41.6	42.0	43.7	43.2	43.2	47.5	47.5	47.3	48.9	48.7	48.7
Means	44.61	46.64	46.85	44.60	46.56	46.82	46.87	46.82	47.20	46.80	46.62	46.34	47.97	47.83	47.85	50.82	50.80	50.76	51.93	51.88	51.87

OCTOBER, 1892.

	Maximum and Minimum Thermometers.		Terrestrial Radiation and Sun Thermometer.		Sunshine.	Precipitation.			Wind. Anemometer observed at 1 P.M. daily.		
Day.	Maximum.	Minimum.	Terrestrial Radiation.	Sun Thermometer.	Hours of Sunshine.	Time of beginning.	Time of ending.	Amount of rain in inches.	Reading.	Number of miles in last twenty-four hours.	Average rate per hour.
	o	o	o	o							
1	54.1	43.2	33.6	120 0	8.5				141.2	436.4	18.18
2	50.5	33.0	28.6	110.2	8				550.8	409.6	17.07
3	49.5	24.8	17.5	96.2	2	2 P.M.			638.3	87.5	3.65
4	52.5	42.0	39.0	76.1	0		6 P.M.	.46	757.4	119.1	4 96
5	51.2	33.7	27.7	111.5	2				888.0	130.6	5.44
6	51.4	35.4	30.4	100.0	2				223.2	325.2	13.55
7	61.2	35.7	30.0	110.5	0				509.8	286.6	11.94
8	68.5	42.5	37.0	117.5	8	9 P.M.			641.3	131.5	5.48
9	58.2	39.8	38.2	64.5	0.5		10.30 A.M.	.30	791.2	149.9	6 25
10	54.8	28 4	22.6	111.1	10				913.5	122.3	5.10
11	50.1	36.8	26.0	117.9	9.5				71.8	148.3	6.18
12	52.6	25.8	18.0	108.7	11				283.5	211.7	8.28
13	50.0	23.5	16.5	68.2	0.5				333.5	50.0	2.08
14	67.2	45.0	37.3	113.0	7				508.3	174.8	7.28
15	60.2	31.3	23 8	112.8	10				678.0	169.7	7.07
16	54.1	44.7	39.8	56.0	0				876.7	198.7	8.28
17	50.1	36.6	25.5	103.3	8.5				151.8	265.1	10.05
18	54.9	22.7	17.2	117.4	6				246.5	94.7	3.95
19	53.0	38.1	32.2	55.0	0	10 A.M.	4 P.M.	.07	387.1	140.6	5.86
20	54.0	38.9	30.0	108.5	8				590.5	203.4	8.48
21	51.1	33.3	23.5	102.0	7.5				895.8	305.3	12.68
22	56.2	33.0	31.8	102.6	10.5				294.5	388.7	16.20
23	51.2	31.3	22.2	105.0	2.5	10.40 A.M.	1.30 P.M.	.06	455.2	160.7	6.70
24	49.0	37.8	32.6	96.4	3				758.3	303.1	12.63
25	53.1	35.3	25.8	102.2	4				38.9	270.6	11.28
26	47.2	34.0	25.8	60.0	0				139.8	100.9	4.20
27	50.8	38.5	33.0	100.0	0.5				218.5	78.7	3.28
28	52.6	35.7	28.6	106.7	7				281.0	62.5	2.60
29	46.8	27.3	22.0	101.8	3	2 P.M.	Night	.57	342.5	61.5	2.56
30	48.6	32 5	29.5	103.8	7				661.8	319.3	13.30
31	45.4	28.8	22.8	67.4	2.5				927.8	266.0	11.08
				Total	149		Total	146	Total	6173.0	
Means	53.16	34.47	28.02	97.62	4.8					199.13	8.26

MAINE AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 4.

SECOND SERIES.

TESTING CREAM AND MILK FAT TEST AND LACTOMETER.

J. M. Bartlett.

Notes on Testing Cream.

As many creameries are adopting the fat test as a measure by which to pay for their cream, it is of the utmost importance that the samples for the test should be properly taken. Cream from a herd of several cows raised at the proper temperature and skimmed in a proper manner will not vary much in butter fat from day to day, but all patrons are not sufficiently careful in skimming and handling their cream so that it is subject to no small amount of variation, causing the creamery man considerable trouble.

The skimming should never be done by dipping the cream from the top of the milk, as this method always involves a loss of both cream and skimmed milk. The loss of cream is from its being mixed with the milk by the dipping and the loss of milk to the farmer is by a large amount being taken up with the cream in an effort to secure all the cream. This milk is taken to the factory and is a total loss to the farmer. The skimming should be done as cleanly as possible and this is best accomplished by a faucet near the bottom of the can. The next best thing is a syphon by means of which the milk or cream can be drawn off separately.

The above mentioned difficulties to the creamery managers, however, can be wholly overcome by the composite sample, first recommended for milk by Prof. Patrick, of the Iowa Experiment Station. There are several ways of taking this sample. One is to provide the collector with a measuring can and a small can marked with the patron's name or number in which to put the sample. The cream is measured, then thoroughly mixed and a portion taken out, put in the sample can and sealed. The amount taken should be an aliquot part of the whole.

If need be the small can may be spaced or marked, as some dealers in dairy supplies have suggested, the same as the measuring can. Then as many spaces or inches of cream can be put in the sample can as there are in the measuring can. Such samples are taken every time a patron's cream is collected, sent to the factory, put in another can or jar marked with the patron's name and kept in an ice chest until the test is made. This constitutes the composite sample which, when tested at the end of one or two weeks as desired, will show accurately the per centage of fat in the patron's cream for that period. With this per centage and the weight of cream furnished, the exact number of pounds of butter fat supplied by this patron can be calculated.

Another method of taking the sample is to bring the cream of each patron to the factory in a can by itself and then take the sample. This involves having a large number of cans for collecting and in some cases is not practical, but on the other hand the man that makes the test has an opportunity to see that the sample is properly taken.

In some cases it is desirable to defer testing for quite a time and the portion of cream reserved for the test becomes sour and curdled. When in this condition it is best brought into shape for measuring in the pipette by the method suggested by Mr. E. H. Farrington, Illinois Station, for handling sour milk, which is, to add to the sample a small amount of "Concentrated Lye" (caustic soda) in powder, about one-half teaspoonful to a pint of cream and heat to about 110° to 125° F, shake thoroughly and allow to cool, when it will be found in as good condition to measure as when fresh.

In regard to apportioning the proceeds, or paying by the test, we will simply repeat what was said in a previous bulletin, that we think it better not to calculate the fat to butter, but allow each patron such a share of the butter made for a given period as the amount of fat he furnished shows he is entitled to receive.

For instance, suppose that a creamery makes 10,000 pounds of butter in a week and receives from its patrons 8,200 pounds butter fat according to test. Mr. A. furnished 82 pounds of that butter fat; then he is entitled to one hundredth of 10,000 or 100 pounds of butter. Butter ordinarily contains from 79 to 87 per cent. butter fat; a correct average, therefore, would be about 83 per cent. for those parties who find it more convenient to calculate the fat over to butter.

In Bulletin No. 3, of this Station, two formsof cream bottles are described. The one designated as cream bottle No. 2, graduated to read to 25 per cent. fat, was at that time recommended for use in testing cream raised by the cold deep setting process in prefers ence to the bottle with a separable neck, which is shown by the accompanying cut and designated as test bottle No. 3. Since that time the writer has made many tests with bottle No. 3, and prefers it in many respects to any other form for the following reasons:

1st. The base is the portion most liable to break and is comparatively inexpensive.

2nd. A large number of the bases can be had at small cost, allowing samples to be measured out and put away to test at some more convenient time. Only one set of the more costly graduated necks are needed to carry on the work.

3rd. The fat can be measured more accurately as all the bottles are set in a tank of water heated to 110 to 120 Fah., and the per cent. of fat is read at a uniform temperature.

4th. Because cream very rich in fat can be tested.

Method of Working with This Bottle. Measure 18c. c. of cream into the base portion of the bottle in the manner given in the directions for measuring milk. Then measure in about 18c. c. of sulphuric acids spe. grav. 1.82–1.83, thoroughly mix the acid with the cream, place the bottle, without the neck, in the centrifugal machine and whirl five minutes at the rate of 800 to 900 revolutions per minute, then fill nearly full with hot water and whirl for two minutes more to bring the fat on top the water, remove from the machine without shaking, and connect the base with the graduated neck by means of a short rubber tube supplied for the purpose, and stand in a small tank filled with water heated to 110 to 120 F. The tank must be deep enough to allow the water to come up within an inch or two of the top of the neck. The fat is now raised into the neck by filling the bottle to the 33 or 34 mark with a hot mixture of acid and water, one part acid to two of water. In making this mixture the acid should always be poured into the water, and if used immediately no heating will be required. In five to ten minutes after the neck is filled the fat will have risen in a solid column and the percentage may be read the same as in case of milk bottles.

It will sometimes be noticed that in adding water to the bottles after the first whirling the fat is not clear and yellow, but light

colored and muddy. This latter condition is usually caused by too little acid being used, and can be remedied by adding a little more acid, shaking and whirling the bottle again. If the fat has curd mixed with it the reading will be too high.

In ordering the bottles described above, parties should be particular to state that "cream bottle No. 3" is wanted.

We would not advise getting larger than a twenty bottle machine, and we would order two dozen graduated necks and four or five dozen bases for a machine of that size. Dealers furnishing these bottles should always fit them with the piece of rubber tubing to connect the base with the neck.

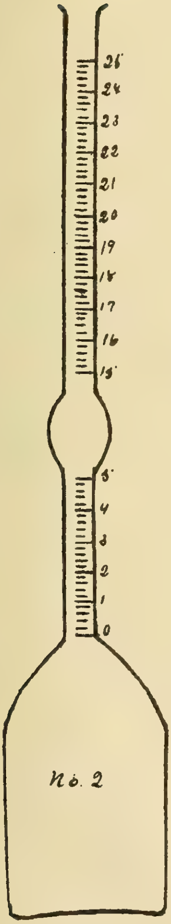
A very convenient way of handling the acid, is to have a glass stoppered burette holding three or four charges, so fastened to a shelf or stand that it can be filled by a glass stoppered syphon passing into a large acid bottle above.

This syphon is filled with acid by blowing into the bottle through a small piece of rubber tubing connected with a piece of glass tubing passing through the stopper which should fit the acid bottle perfectly.

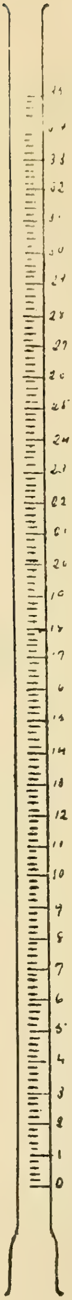
This piece of apparatus with a gallon bottle can be supplied by glass dealers for about $4.00.

For filling the bottles with hot water, we would recommend a galvanized iron tank placed above the centrifugal machine, with a faucet near the bottom to which is attached a piece of rubber tubing three feet long with a glass nozzle which can be moved around to each of the bottles where they stand in the machine.

NOTE. The writer has designed a bottle for determining the fat in butter made similar to No. 3, except the middle portion of the neck is enlarged like a pipette. The small portions above and below the enlargement are graduated the same as the milk bottles. The range of readings is from 70 to 90 per cent. fat using 18 grams of butter. The efficiency of this bottle has not yet been tested.


25
24
23
22
21
20
19
18
17
16
15
5
4
3
2
1
0
No. 2


No. 3



The Lactometer and Fat Test for Cheese and Condensed Milk Factories.

Within the last few months some inquiries have been received from parties interested in cheese and condensed milk factories in regard to a test to determine the quality of the milk received at these institutions.

The fat test which very accurately tells the butter value of milk does not give its actual value for making cheese or condensed milk. For instance, a factory may require milk of a certain standard, for instance 3 per cent. fat. Such milk should contain about 9 per cent. solids not fat. A patron may have milk that contains 6 per cent. fat and 10 per cent. other solids. If he should dilute this milk 50 per cent. with water it would then contain 3 per cent. fat and appear by the fat test alone to be up to the standard, while it would be worth but little more than half as much for cheese or condensed milk because it would contain but 5 per cent. solids not fat. Therefore it is necessary to have recourse to some method to detect adulterations besides the fat test, to protect the above institutions and milk buyers in general against fraud. It seems the height of folly for our cheese and condensed milk factories to go on paying for milk by quantity without regard to quality. It is simply putting a premium on dishonesty and poor milk. For who would turn milk from a nice Jersey herd into a factory if he received only the same price per pound as his neighbor who has a herd of ordinary animals yielding milk of much less value.

The most common adulterations are the removing of cream and the addition of water. By determining the fat and the solids not fat, either or both of these adulterations are easily detected.

In many states legal standards for fat and solids not fat have been established in order to protect the public against fraud. In some states the required standard is 3 per cent. fat, others 3.5 per cent. and solids not fat about 9 per cent. Milk from a good sized herd varies but little from day to day. Milk from a single cow may vary quite widely in fat, but from a herd will seldom vary more than 0.2 or 0.3 per cent. and solids not fat even less.

It is rather difficult to fix any standard, so great is the variation in different animals, but it is very rare that the mixed milk from a large herd at any season of the year will fall below 12 per cent. total solids unless it has been diluted. Milk containing less than 9 per cent. solids not fat is suspicious, and a sample containing

much less than 8.5 is probably watered. When a standard is adopted the only course to pursue is to consider all milk falling below this standard adulterated. If the milk is not up to the standard it matters not whether it is from poor cows or is diluted after milking, the results are the same.

It is necessary therefore in order to detect adulterations to determine both the fat and the other solids. For the determination of the former we would recommend the Babcock test described in Bulletin No. 3 of this Station and Bulletins Nos. 24 and 31 of Wis. Experiment Station, and then the solids not fat can be quite readily and accurately estimated from the specific gravity and per cent. of fat. The specific gravity of whole milk at 60 F. varies from 1.030 to 1.034. This means that when a certain volume of distilled water at 60 F. weighs just 1000 lbs the same volume of milk will weigh 1.030 to 1.034 lbs. The solids not fat, namely, the casein, albumen, milk, sugar and mineral matter are the constituents of milk that are heavier than water and therefore cause its greater weight. On the other hand the fat is lighter, consequently the abstraction of fat increases the specific gravity, and the addition of water decreases the specific gravity so one can readily tell whether the milk has been skimmed or diluted with water by these two tests. For example suppose a sample of whole milk contains 4.2 per cent. fat, and has a specific gravity of 1.032. If this milk were diluted one half with water it would contain 2.1 per cent. fat and have a specific gravity of about 1.016, while if it were partially skimmed to contain about 2.1 per cent. fat its specific gravity would be increased to about 1.0345.

The Lactometer.

The instrument we would recommend for taking the specific gravity is the lactometer, which is sufficiently accurate for practical purposes. There are several kinds in use at the present time, all of which are made on the same general principle, viz: A narrow stem attached to an elongated bulb weighted at the bottom so that it will maintain an upright position when floating in the milk, with the stem which is graduated partially submerged.

The mark on the stem to which it sinks shows the specific gravity. The instrument we would recommend for this purpose is the Quevenne lactometer. The scale on the stem expresses in thousands the weight of the liquid in which it is placed as compared with water. The graduations are usually from 15 to 40

degrees. To illustrate, milk having a specific gravity of 1.032 would give a reading of 32 on the Lactometer and one having a specific gravity of 1,025 would give a reading of 25.

METHOD OF MAKING THE TEST.

The method of making the fat test has been already described in the bulletins referred to. To take the specific gravity with the lactometer it is necessary, 1st that milk be free from air bubbles, and in order to insure this it should stand at least one half hour after being drawn; 2nd. that it should be thoroughly mixed by pouring carefully from one vessel to another, avoiding any violent motions that would be likely to collect air bubbles, then brought to the proper temperature, 60° F., placed in a vessel of sufficient depth and diameter to allow the lactometer to float freely, and the mark on the stem to which the instrument sinks, read. In case it is not convenient to bring the milk to just the temperature of 60° F., a correction may be made where the variation is not more than 10 degrees, by adding to the lactometer reading 0.1 for each degree the temperature exceeds 60, and subtracting 0.1 for each degree below 60. For example, a lactometer reading of 32 at 65° F., corrected, would read 32.5; at 55° F., corrected, 31.5.

After finding the per cent. of fat, and taking the lactometer reading the per cent. of solids not fat may be found by the table given on the following pages.

Find the per cent. of fat in one of the vertical columns, either to the right or left of the table and the lactometer reading at the top of the table in the line of figures marked lactometer reading, then look down the column of figures directly under the lactometer reading till on line with the per cent. of fat, and the figures found at this point will be the per cent. of solids not fat in the milk.

For example, suppose the per cent. of fat is 4.5 and the lactometer reading is 32, then the per cent. of solids not fat will be 9.28. The lactometer can easily be read to half degrees when necessary to be quite accurate. Suppose the lactometer reads 31.5 instead of 32 in the above example, then the per cent. of solids not fat would be 9.15. The per cent. of solids not fat added to the per cent. of fat gives total solids.

By means of the methods given, any person of ordinary intelligence and skill, can with a little practice, readily determine the value of milk quite accurately.

After adopting the test, the factory and its patrons must agree upon some method of paying for the milk. There are two or three ways of doing this. One is to adopt a standard, say 3.5 per cent. fat, 9 per cent. other solids and fix a price for milk of this standard. Then pay for milk, testing above or below these figures, more or less in proportion as it tests. Another method is to fix the price per pound for fat and other solids, and determine by the test the number of pounds furnished by each patron. Still another is to fix the price per pound for total solids. Total solids are found by adding the percentage of fat to the percentage of solids found by the table.

Some doubtless will complain that these tests involve too much labor to be practical, but in regard to this we will say, that after one has had some practice, the time required to make the tests is much less than one would suppose. A man can easily test 20 samples in two hours for both fat and other solids. The fat test takes the greater part of the time, and that need not be made more than once a week, especially if the composite sample mentioned in "notes on cream testing" be used.

All lactometer readings must be taken before the milk sours. Quite a number of formulas have been made for estimating solids not fat from the specific gravity and the per cent. of fat, but the table here given is made from one presented by Dr. Babcock, Bulletin No. 31 Wis. Agr. Experiment Station.

The writer has made quite a large number of comparisons in determining solids by this table and by the gravity process, and finds the agreement close enough for practical purposes.

The results can be found on the following pages. The table for solids not fat is so arranged, that it can be taken from the bulletin and mounted on card board for use.

The apparatus for these tests can be obtained from most dealers in dairy supplies. The Quevenne lactometer should always be ordered to use with the table given.

Name of Cow.	Fat.	Solids not Fat. Gravemetric Method.	Solids not Fat. Babcock Test and Lactometer.	Name of Cow.	Fat.	Solids not Fat. Gravemetric Method.	Solids not Fat. Babcock Test and Lactometer.
	%	%	%		%	%	%
Nancy......	2.60	8.87	8.87	Agnes	4.30	9.34	9.40
(Ayershire)	3.50	8.80	8.93	(Jersey)	5.50	9.20	9.23
	2.80	8.95	8.75		4.45	9.15	9.41
	3.60	8.89	8.90		5.15	9.25	9.43
	2.70	8.94	8.82		5.00	9.13	9.12
	3.50	8.84	8.90		4.95	9.29	9.37
	2.85	9.07	8.82		4.55	9.17	9.40
	3.50	9.16	8.90		5.30	9.30	9.58
	3.10	8.70	8.85		5.30	9.23	9.34
	2.71	8.63	8.76		4.41	9.13	9.26
	3.40	8.65	8.39		5.00	9.00	9.26
	2.80	8.56	8.60		4.50	9.33	9.15
	3.20	8.43	8.74		5.05	9.22	9.25
	2.70	8.80	8.76		4.55	9.05	9.17
Average ...	....	**8.81**	**8.78**	Average ...	....	**9.20**	**9.31**
Dinsmore ..	4.55	9.45	9.56	L. T.......	4.10	9.27	9.33
(Jersey)	5.80	9.65	9.82	(Jersey)	4.80	9.11	9.32
	5.45	9.90	9.60		4.05	9.23	9.19
	5.40	9.65	9.74		4.75	9.21	9.32
	4.10	9.74	9.60		3.80	9.42	9.26
	5.45	9.69	10.00		4.50	9.36	9.35
	4.50	9.56	9.63		4.20	9.32	9.34
	5.00	9.55	9.78		4.95	9.88	9.52
	6.10	9.49	9.62		4.75	8.92	9.32
	4.42	9.43	9.61		3.83	9.06	9.26
	5.60	9.63	9.65		4.55	9.25	9.28
	4.40	9.63	9.28		3.80	9.20	9.13
	5.15	9.59	9.68		4.65	8.93	9.30
	4.60	9.51	9.56		3.85	9.18	9.26
Average ...	....	**9.61**	**9.65**	Average ...	....	**9.24**	**9.23**
Shaw	4.65	9.72	9.56	Herd.......	3.70	9.20	9.11
(Grade)	6.35	9.55	9.34		3.40	8.70	8.78
	4.60	9.86	9.83		3.40	9.40	9.57
	5.65	9.80	9.68		3.20	8.70	9.00
	5.15	9.97	9.69		3.60	9.80	9.61
	6.25	9.70	9.66		4.00	9.60	9.70
	4.80	9.82	9.74	P'r'ly skm'd	1.20	10.40	10.14
	5.60	9.75	9.78	Watered ...	2.00	4.80	4.83
	6.10	9.36	9.62	" ...	2.25	6.70	6.96
	5.00	9.82	9.80	Skimmed ..	0.20	9.32	9.30
	6.00	9.50	9.60				
	5.00	9.72	9.65				
	5.60	9.44	9.55				
	5.20	9.55	9.43				
Average ...	....	**9.68**	**9.64**				

Table showing per cent. of solids not fat corresponding to per cent. of fat and Quevenne lactometer reading.

Per cent. of Fat.	Lactometer Reading.																								Per cent. of Fat.
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
0.1	4.44	4.70	4.96	5.22	5.48	5.74	6.00	6.26	6.52	6.78	7.04	7.30	7.56	7.82	8.08	8.34	8.60	8.86	9.12	9.38	9.64	9.90	10.16	10.42	0.1
0.2	4.46	4.72	4.98	5.24	5.50	5.76	6.02	6.28	6.54	6.80	7.06	7.32	7.58	7.84	8.10	8.36	8.62	8.88	9.14	9.40	9.66	9.92	10.18	10.44	0.2
0.3	4.48	4.74	5.00	5.26	5.52	5.78	6.04	6.30	6.56	6.82	7.08	7.34	7.60	7.86	8.12	8.38	8.64	8.90	9.16	9.42	9.68	9.94	10.20	10.46	0.3
0.4	4.50	4.76	5.02	5.28	5.54	5.80	6.06	6.32	6.58	6.84	7.10	7.36	7.62	7.88	8.14	8.40	8.66	8.92	9.18	9.44	9.70	9.97	10.23	10.49	0.4
0.5	4.52	4.78	5.04	5.30	5.56	5.82	6.08	6.34	6.60	6.86	7.12	7.38	7.64	7.90	8.16	8.42	8.68	8.95	9.21	9.47	9.73	9.99	10.25	10.51	0.5
0.6	4.54	4.80	5.06	5.32	5.58	5.84	6.10	6.36	6.62	6.88	7.14	7.40	7.66	7.93	8.19	8.45	8.71	8.97	9.23	9.49	9.75	10.01	10.27	10.53	0.6
0.7	4.56	4.82	5.08	5.34	5.60	5.86	6.12	6.38	6.64	6.91	7.17	7.43	7.69	7.95	8.21	8.47	8.73	8.99	9.25	9.51	9.77	10.03	10.29	10.55	0.7
0.8	4.58	4.84	5.10	5.36	5.62	5.88	6.14	6.40	6.67	6.93	7.19	7.45	7.71	7.97	8.23	8.49	8.75	9.01	9.27	9.53	9.79	10.05	10.31	10.57	0.8
0.9	4.60	4.86	5.12	5.38	5.64	5.90	6.17	6.43	6.69	6.95	7.21	7.47	7.73	7.99	8.25	8.51	8.77	9.03	9.29	9.55	9.81	10.07	10.33	10.59	0.9
1.0	4.62	4.88	5.14	5.40	5.66	5.93	6.19	6.45	6.71	6.97	7.23	7.49	7.75	8.01	8.27	8.53	8.79	9.05	9.31	9.57	9.83	10.09	10.35	10.61	1.0
1.1	4.64	4.90	5.17	5.43	5.69	5.95	6.21	6.47	6.73	6.99	7.25	7.51	7.77	8.03	8.29	8.55	8.81	9.07	9.34	9.59	9.85	10.12	10.38	10.64	1.1
1.2	4.66	4.92	5.19	5.45	5.71	5.97	6.23	6.49	6.75	7.01	7.27	7.53	7.79	8.05	8.31	8.57	8.83	9.09	9.35	9.62	9.88	10.14	10.40	10.66	1.2
1.3	4.68	4.95	5.21	5.47	5.73	5.99	6.25	6.51	6.77	7.03	7.29	7.55	7.81	8.07	8.33	8.59	8.85	9.12	9.38	9.64	9.90	10.16	10.42	10.68	1.3
1.4	4.70	4.97	5.23	5.49	5.75	6.01	6.27	6.53	6.79	7.05	7.31	7.57	7.83	8.09	8.36	8.62	8.88	9.14	9.40	9.66	9.92	10.18	10.44	10.70	1.4
1.5	4.73	4.99	5.25	5.51	5.77	6.03	6.29	6.55	6.81	7.07	7.33	7.59	7.85	8.12	8.38	8.64	8.90	9.16	9.42	9.68	9.94	10.20	10.46	10.72	1.5
1.6	4.75	5.01	5.27	5.53	5.79	6.05	6.31	6.57	6.83	7.09	6.35	7.61	7.88	8.14	8.40	8.66	8.92	9.18	9.44	9.70	9.96	10.22	10.48	10.75	1.6
1.7	4.77	5.03	5.29	5.55	5.81	6.07	6.33	6.59	6.85	7.11	7.38	7.64	7.90	8.16	8.42	8.68	8.94	9.20	9.46	9.72	9.98	10.25	10.51	10.77	1.7
1.8	4.79	5.05	5.31	5.57	5.83	6.09	6.35	6.61	6.87	7.14	7.40	7.66	7.92	8.18	8.44	8.70	8.96	9.22	9.48	9.75	10.01	10.27	10.53	10.79	1.8
1.9	4.81	5.07	5.33	5.59	5.85	6.11	6.37	6.63	6.90	7.16	7.42	7.68	7.94	8.20	8.46	8.72	8.98	9.24	9.51	9.77	10.03	10.29	10.55	10.81	1.9
2.0	4.83	5.09	5.35	5.61	5.87	6.13	6.39	6.65	6.92	7.18	7.44	7.70	7.96	8.22	8.48	8.74	8.01	9.27	9.53	9.79	10.05	10.31	10.57	10.83	2.0
2.1	4.85	5.11	5.37	5.63	5.89	6.15	6.41	6.68	6.94	7.20	7.46	7.72	7.98	8.24	8.50	8.77	9.03	9.29	9.55	9.81	10.07	10.33	10.59	10.86	2.1
2.2	4.87	5.13	5.39	5.65	5.91	6.17	6.44	6.70	6.96	7.22	7.48	7.74	8.00	8.26	8.53	8.79	9.05	9.31	9.57	9.83	10.09	10.35	10.62	10.88	2.2
2.3	4.89	5.15	5.41	5.67	5.93	6.19	6.46	6.72	6.98	7.24	7.50	7.76	8.02	8.29	8.55	8.81	9.07	9.33	9.59	9.85	10.11	10.38	10.64	10.90	2.3
2.4	4.91	5.17	5.43	5.69	5.95	6.22	6.48	6.74	7.00	7.26	7.52	7.78	8.05	8.31	8.57	8.83	9.09	9.35	9.61	9.87	10.14	10.40	10.66	10.92	2.4
2.5	4.93	5.19	5.45	5.71	5.98	6.24	6.50	6.76	7.02	7.28	7.54	7.81	8.07	8.33	8.59	8.85	9.11	9.37	9.63	9.90	10.16	10.42	10.68	10.94	2.5
2.6	4.95	5.21	5.47	5.73	6.00	6.26	6.52	6.78	7.04	7.30	7.56	7.83	8.09	8.35	8.61	8.87	9.13	9.39	9.66	9.92	10.18	10.44	10.70	10.96	2.6
2.7	4.97	5.23	5.49	5.76	6.02	6.28	6.54	6.80	7.06	7.32	7.59	7.85	8.11	8.37	8.63	8.89	9.16	9.42	9.68	9.94	10.20	10.46	10.72	10.99	2.7
2.8	4.99	5.25	5.51	5.78	6.04	6.30	6.56	6.82	7.08	7.35	7.61	7.87	8.13	8.39	8.65	8.92	9.18	9.44	9.70	9.96	10.22	10.48	10.75	11.01	2.8
2.9	5.01	5.27	5.54	5.80	6.06	6.32	6.58	6.84	7.10	7.37	7.63	7.89	8.15	8.41	8.67	8.94	9.20	9.46	9.72	9.98	10.24	10.51	10.77	11.03	2.9
3.0	5.03	5.29	5.56	5.82	6.08	6.34	6.60	6.86	7.13	7.39	7.65	7.91	8.17	8.43	8.70	8.96	9.22	9.48	9.74	10.00	10.27	10.53	10.79	11.05	3.0
3.1	5.05	5.31	5.58	5.84	6.10	6.36	6.62	6.88	7.15	7.41	7.67	7.93	8.19	8.46	8.72	8.98	9.24	9.50	9.76	10.03	10.29	10.55	10.81	11.07	3.1
3.2	5.07	5.33	5.60	5.86	6.12	6.38	6.64	6.90	7.17	7.43	7.69	7.95	8.21	8.48	8.74	9.00	9.26	9.52	9.78	10.05	10.31	10.57	10.83	11.09	3.2
3.3	5.09	5.36	5.62	5.88	6.14	6.40	6.66	6.93	7.19	7.45	7.71	7.97	8.24	8.50	8.76	9.02	9.28	9.55	9.81	10.07	10.33	10.59	10.85	11.12	3.3
3.4	5.11	5.38	5.64	5.90	6.16	6.42	6.69	6.95	7.21	7.47	7.73	8.00	8.26	8.52	8.78	9.04	9.30	9.57	9.83	10.09	10.35	10.61	10.88	11.14	3.4
3.5	5.14	5.40	5.66	5.92	6.18	6.44	6.71	6.97	7.23	7.49	7.75	8.02	8.28	8.54	8.80	9.06	9.33	9.59	9.85	10.11	10.37	10.64	10.90	11.16	3.5
3.6	5.16	5.42	5.68	5.94	6.20	6.45	6.73	6.99	7.25	7.51	7.78	8.04	8.30	8.56	8.82	9.09	9.35	9.61	9.87	10.13	10.40	10.66	10.92	11.18	3.6
3.7	5.18	5.44	5.70	5.96	6.22	6.49	6.75	7.01	7.27	7.53	7.80	8.06	8.32	8.58	8.84	9.11	9.37	9.63	9.89	10.16	10.42	10.68	10.94	11.20	3.7
3.8	5.20	5.46	5.72	5.98	6.24	6.51	6.77	7.03	7.29	7.56	7.82	8.08	8.34	8.60	8.87	9.13	9.39	9.65	9.91	10.18	10.44	10.70	10.96	11.23	3.8
3.9	5.22	5.48	5.74	6.00	6.27	6.53	6.79	7.05	7.31	7.58	7.84	8.10	8.36	8.63	8.89	9.15	9.41	9.67	9.94	10.20	10.46	10.72	10.99	11.25	3.9
4.0	5.24	5.50	5.76	6.02	6.29	6.55	6.81	7.07	7.34	7.60	7.86	8.12	8.38	8.65	8.91	9.17	9.43	9.70	9.96	10.22	10.48	10.75	11.01	11.27	4.0
4.1	5.26	5.52	5.7	6.04	6.31	6.57	6.83	7.09	7.36	7.62	7.88	8.14	8.41	8.67	8.93	9.19	9.46	9.72	9.98	10.24	10.50	10.77	11.03	11.29	4.1
4.2	5.28	5.54	5.80	6.07	6.33	6.59	6.85	7.12	7.38	7.64	7.90	8.16	8.43	8.69	8.95	9.21	9.48	9.74	10.00	10.26	10.53	10.79	11.05	11.31	4.2
4.3	5.30	5.56	5.82	6.09	6.35	6.61	6.87	7.14	7.40	7.66	7.92	8.19	8.45	8.71	8.97	9.24	9.50	9.76	10.02	10.29	10.55	10.81	11.07	11.34	4.3
4.4	5.32	5.58	5.84	6.11	6.37	6.63	6.89	7.16	7.42	7.68	7.94	8.21	8.47	8.73	8.99	9.26	9.52	9.78	10.04	10.31	10.57	10.83	11.09	11.36	4.4
4.5	5.34	5.60	5.86	6.13	6.39	6.65	6.92	7.18	7.44	7.70	7.97	8.23	8.49	8.75	9.02	9.28	9.54	9.80	10.07	10.33	10.59	10.85	11.12	11.38	4.5
4.6	5.36	5.62	5.89	6.15	6.41	6.67	6.94	7.20	7.46	7.73	7.09	8.25	8.51	8.77	9.04	9.30	9.56	9.83	10.09	10.35	10.61	10.88	11.14	11.40	4.6
4.7	5.38	5.64	5.91	6.17	6.43	6.69	6.96	7.22	7.48	7.75	8.01	8.27	8.53	8.80	9.06	9.32	9.58	9.85	10.11	10.37	10.64	10.90	11.16	11.42	4.7
4.8	5.40	5.66	5.93	6.19	6.45	6.72	6.98	7.24	7.50	7.77	8.03	8.29	8.55	8.82	9.08	9.34	9.61	9.87	10.13	10.39	10.66	10.92	11.18	11.45	4.8
4.9	5.42	5.69	5.95	6.21	6.47	6.74	7.00	7.26	7.53	7.79	8.05	8.31	8.58	8.84	9.10	9.37	9.63	9.89	10.15	10.42	10.68	10.94	11.20	11.47	4.9
5.0	5.44	5.71	5.97	6.23	6.49	6.76	7.02	7.28	7.55	7.81	8.07	8.33	8.60	8.86	9.12	9.39	9.65	9.91	10.17	10.44	10.70	10.96	11.23	11.49	5.0
5.1	5.46	5.73	5.99	6.25	6.52	6.78	7.04	7.30	7.57	7.83	8.09	8.36	8.62	8.88	9.15	9.41	9.67	9.93	10.20	10.46	10.72	10.99	11.25	11.51	5.1
5.2	5.48	5.75	6.01	6.27	6.54	6.80	7.06	7.33	7.59	7.85	8.11	8.38	8.64	8.90	9.17	9.43	9.69	9.96	10.22	10.48	10.74	11.01	11.27	11.53	5.2
5.3	5.51	5.77	6.03	6.29	6.56	6.82	7.08	7.35	7.61	7.87	8.14	8.40	8.66	8.92	9.19	9.45	9.71	9.98	10.24	10.50	10.77	11.03	11.29	11.55	5.3
5.4	5.53	5.79	6.05	6.31	6.58	6.84	7.10	7.37	7.63	7.89	8.16	8.42	8.68	8.95	9.21	9.47	9.74	10.00	10.26	10.52	10.79	11.05	11.31	11.58	5.4
5.5	5.55	5.81	6.07	6.34	6.60	6.86	7.13	7.39	7.65	7.92	8.18	8.44	8.70	8.97	9.23	9.49	9.76	10.02	10.28	10.55	10.81	11.07	11.34	11.60	5.5
5.6	5.57	5.83	6.09	6.36	6.62	6.88	7.15	7.41	7.67	7.94	8.20	8.46	8.73	8.99	9.25	9.52	9.78	10.04	10.31	10.57	10.83	11.10	11.36	11.62	5.6
5.7	5.59	5.85	6.11	6.38	6.64	6.90	7.17	7.43	7.69	7.96	8.22	8.48	8.75	9.01	9.27	9.54	9.80	10.06	10.33	10.59	10.85	11.12	11.38	11.64	5.7
5.8	5.61	5.87	6.13	6.40	6.66	6.92	7.19	7.45	7.72	7.98	8.24	8.50	8.77	9.03	9.30	9.56	9.82	10.09	10.35	10.61	10.88	11.14	11.40	11.67	5.8
5.9	5.63	5.89	6.16	6.42	6.68	6.95	7.21	7.47	7.74	8.00	8.26	8.53	8.79	9.05	9.32	9.58	9.84	10.11	10.37	10.63	10.90	11.16	11.42	11.69	5.9
6.0	5.65	5.91	6.18	6.44	6.70	6.97	7.23	7.49	7.76	8.02	8.28	8.55	8.81	9.07	9.34	9.60	9.87	10.13	0.39	10.66	10.92	11.18	11.45	11.71	6.0
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	